

Daily report

02-09-2020

Analysis and prediction of COVID-19 for EU-EFTA-UK and other countries

Situation report 123

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With the financial support of

Foreword

The present report aims to provide a comprehensive picture of the **pandemic situation of COVID-19** in the EU countries, and to be able to foresee the situation in the next coming days. We provide some figures and tables with several **indexes and indicators** as well as an **Analysis** section that discusses a specific topic related with the pandemic.

As for the predictions, we employ an **empirical model**, verified with the evolution of the number of confirmed cases in previous countries where the epidemic is close to conclude, including all provinces of China. The model does not pretend to interpret the causes of the evolution of the cases but to permit the **evaluation of the quality of control measures made in each state** and a **short-term prediction of trends**. Note, however, that the effects of the measures' control that start on a given day are not observed until approximately 7-14 days later.

We show an individual report with 8 graphs and a summary table with the main indicators for different countries and regions. We are adjusting the model to **countries and regions** with at least 4 days with more than 100 confirmed cases and a current load over 200 cases.

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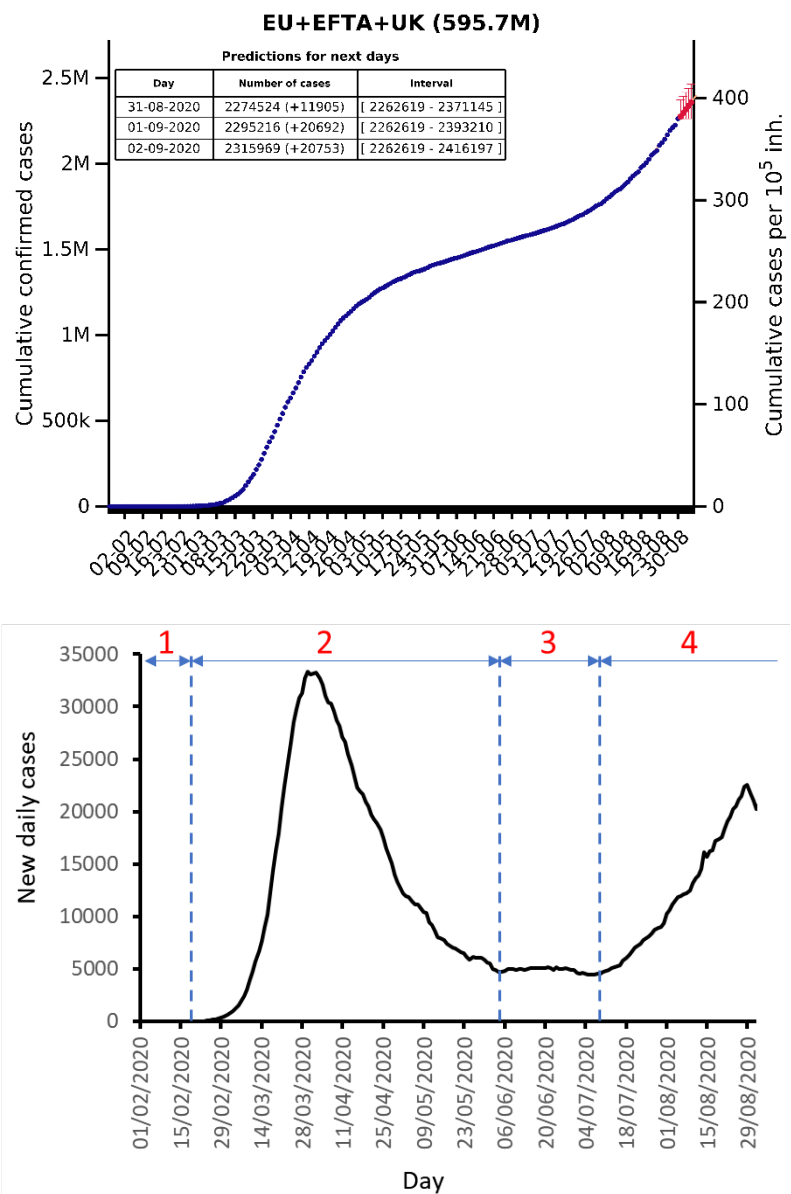
PJC and MC received funding from "la Caixa" Foundation (ID 100010434), under agreement LCF/PR/GN17/50300003; CP, DL, SA, MC, received funding from Ministerio de Ciencia, Innovación y Universidades and FEDER, with the project PGC2018-095456-B-I00;

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Situation and highlights

The evolution of the pandemic in the EU+EFTA+UK as a whole in the last months confirms the presence of four stages in the evolution, as shown in the figure below. A first phase where the cases were probably mostly imported (1). A second stage with a very important growth and with enormous human, social and economic effects where the control is achieved with hard distancing measures (2). A third stage where these control measures are progressively relaxed, reaching a level of new daily cases approximately constant over time (3). And a fourth stage, and last so far, where we have strong growth again (4). **Talking about a second wave is a way of describing the current evolution of the new daily cases. Still, the picture is misleading. Stages 2 and 4 are epidemiologically different.** Many more cases are currently diagnosed in almost all countries, many of them asymptomatic. Hospitals are not saturated, and the number of deaths per reported case is much lower. However, we must recall that the characteristics of the virus have not changed and the number of people who are probably immunized is still very low. If we do not manage to slow down this second wave, we will get closer and closer to the situation of stage 2. In the

last days, there has been a decrease in the number of daily cases, we hope that this trend is not an artifact due to delays in data recording and the situation stabilizes or improves in the following weeks.

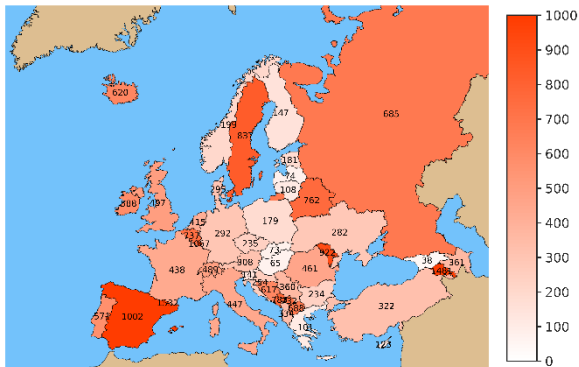


Situation and trends per country

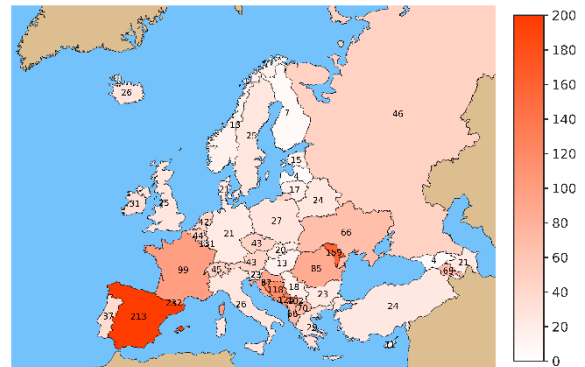
Maps of current situation in EU countries. Colour scale is indicated in each legend.

- Cumulative incidence: total number of reported cases per 100,000 inhabitants
- A_{14} : Cumulative incidence last 14 days per 100,000 inhabitants (active cases)
- ρ_7 : Empiric reproduction number
- EPG: Effective Potential Growth ($EPG = A_{14} \cdot \rho_7$)

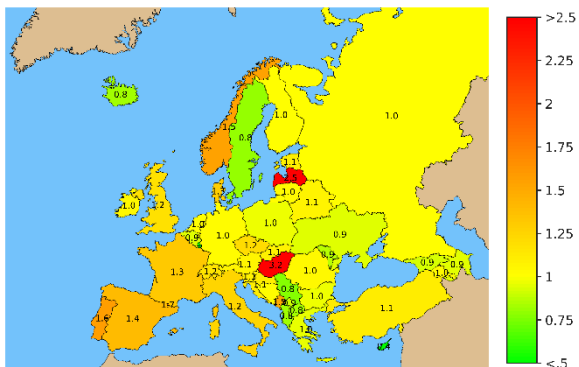
Cumulative incidence



A_{14}



ρ_7



EPG

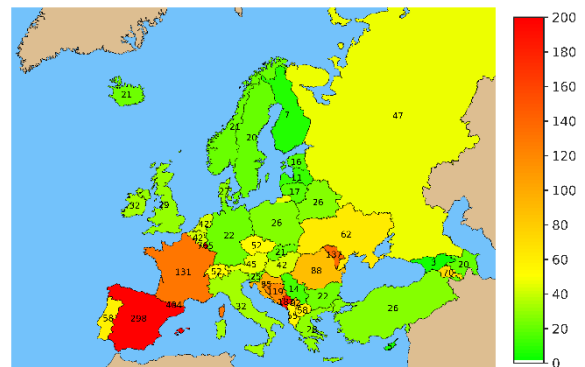


Table of current situation in EU countries. Colour scale is indicated in each legend.

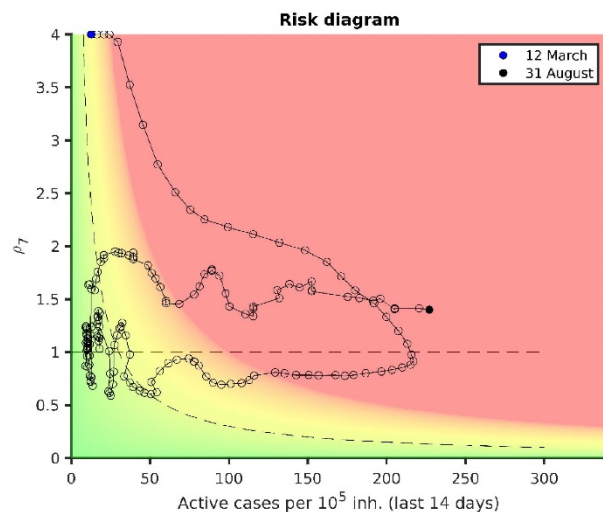
Country	Reported data						Indexes		
	Cumulative cases	Attack rate /10 ⁵ inh.	Cumulative deaths	Mortality /10 ⁵ inh.	Active cases (last 14 days)	14-day attack rate /10 ⁵ inh.	$\rho_7^{(1)}$	EPG _{REP} ⁽²⁾	Biocom-Cov degree
Spain	470,973	1,016.2	29,152	62.9	106,777	230.4	1.37	315	9
United Kingdom	337,168	507.5	41,504	62.5	16,882	25.4	1.18	30	4
France	286,007	441.9	30,661	47.4	64,740	100.0	1.32	132	7
Italy	270,189	454.6	35,491	59.7	15,553	26.2	1.25	33	4
Germany	244,855	298.9	9,313	11.4	17,941	21.9	1.02	22	3
Romania	88,593	447.9	3,681	18.6	16,385	82.8	1.04	86	7
Belgium	85,393	751.8	9,897	87.1	5,135	45.2	0.94	42	4
Sweden	84,521	859.1	5,813	59.1	2,546	25.9	0.79	21	3
Netherlands	71,057	418.3	6,221	36.6	7,146	42.1	1.00	42	5
Poland	67,922	177.7	2,058	5.4	10,046	26.3	0.97	25	4
Portugal	58,243	561.5	1,824	17.6	3,795	36.6	1.57	57	5
Switzerland	42,285	493.4	1,726	20.1	3,933	45.9	1.15	53	5
Ireland	29,025	614.2	1,777	37.6	1,526	32.3	1.04	34	4
Austria	27,741	318.4	734	8.4	3,866	44.4	1.06	47	5
Czech Republic	25,117	236.7	425	4.0	4,634	43.7	1.21	53	5
Denmark	17,084	299.1	625	10.9	1,229	21.5	1.29	28	4
Bulgaria	16,266	228.1	629	8.8	1,597	22.4	0.97	22	3
Norway	10,783	200.9	264	4.9	723	13.5	1.55	21	3
Greece	10,524	94.1	271	2.4	3,052	27.3	0.96	26	4
Croatia	10,414	247.2	187	4.4	3,559	84.5	1.10	93	7
Finland	8,142	148.0	336	6.1	366	6.7	1.01	7	2
Luxembourg	6,677	1,159.2	124	21.5	NA	NA	NA	NA	NA
Hungary	6,257	64.2	616	6.3	1,287	13.2	3.16	42	4
Slovakia	3,989	73.3	33	0.6	1,067	19.6	1.07	21	3
Slovenia	2,933	141.1	128	6.2	477	23.0	1.08	25	4
Lithuania	2,929	100.7	86	3.0	455	15.6	1.03	16	3
Estonia	2,395	182.5	64	4.9	195	14.9	1.09	16	3
Iceland	2,116	580.9	10	2.7	89	24.4	0.82	20	4
Malta	1,909	445.0	12	2.8	427	99.5	NA	NA	6
Cyprus	1,490	127.4	21	1.8	131	11.2	0.43	5	2
Latvia	1,404	71.2	34	1.7	81	4.1	2.54	10	2
Liechtenstein	108	280.1	1	2.6	11	28.5	NA	NA	1

Scale							
Worst	Worst	Worst	Worst	Worst	Worst	2.0	100
Best	Best	Best	Best	Best	Best	0.0	0

⁽¹⁾ ρ_7 is the average of 7 consecutive ρ , but can still fluctuate. ⁽²⁾ EPG_{REP} stands for Effective Growth Potential, which is the product of reported cumulative incidence of last 14 days per 10⁵ inhabitants by ρ_7 (empiric reproduction number). Biocom-Cov degree is an epidemiological situation scale based on the level of last week's mean daily new cases (<https://upcommons.upc.edu/handle/2117/189661>, <https://upcommons.upc.edu/handle/2117/189808>).

Analysis: Spain second wave. A discussion of the hypothesis explaining the high increase in Spanish Covid-19 incidence (I)

The last months of July and August have definitely shown that Covid-19 is not a disease that stops with the Summer. **The prevalence of outdoors activities together with a raise in temperature has not prevented that Spain became the European country with the highest incidence right now.** We show the the risk diagram of Spain, where current penetration into the red zone (high risk) is clearly seen. We must recall the differences between first and second waves: huge differences among diagnostic rates prevent direct comparison of both situations.



It is important to emphasize that Spanish temperatures have not been as high as those in Arizona or Texas, where life usually goes indoor looking for the comfort of lower temperatures with AC. In Spain, **summer presents a characteristically high outdoor life.** Life indoor is reduced everywhere except for nightclubs and formal indoor dining. The number of meetings in outdoor settings like bars and dining terraces, outdoor parties in the street, beach or mountain and friend meetings to do outdoor exercise or just plain conversation is the general norm. Furthermore, with Covid-19 and the closure of indoor nightclubs on the 18th of August for the whole Spain, and during July for some regions or cities like Barcelona, indoor gatherings were reduced to inner dining with heavy restriction on the number of tables that restaurants can use.

If the ratio between outdoor contagion and indoor contagion would be 1 to 20 as in Japan or China, propagation should have been highly reduced. However, this has been clearly not the case. Spain has become the country with the highest incidence right now. The question arises on **why Spain has become the leader of the second outbreak.**

There are basically **three hypotheses** on the table from talk with epidemiologists on the ground, doctors in hospitals and from the analysis of the spatio-temporal data that we do in our group. We address in this report ***the first hypothesis: Spain reopened earlier in epidemiological terms compared with other countries. In this scenario, Spain is just the canary in the coal mine. Other European countries will just follow the Spanish steps.***

The key step for Spanish reopening in the mobility data we track was the opening of inter-province borders. During the confinement and the post-confinement process, mobility between provinces was forbidden. The key measure that signal to the population that normality was returning and that, indeed, introduce movement between provinces was the possibility to move out from your province. This measure allowed the beginning of the holiday season for a lot of Spaniards. The 15th of June the majority of Spain could move but not all, and any restriction was lifted on the 21th of June. It is thus important to recall **the incidence present the week from the 15th of June to the 22th of June for Spain. It was around 10 reported active cases per 100,000 inh.** The real incidence was higher. In June the detection rate was higher than the 10-15% possible in April-May but not extremely higher. Detection rate at that time could be anywhere from 20 to 33%, indicating a real incidence of 30-50 active cases per 100,000 inh.

How does this compare with the incidence of other countries when they reopened? In order to follow with our assessment is good to recover the table we presented on the **22nd of June**.

Country	Reported data						Indexes		
	Cumulative cases	Attack rate /10 ⁵ inh.	Cumulative deaths	Mortality /10 ⁵ inh.	Active cases (last 14 days)	14-day attack rate /10 ⁵ inh.	$\rho_7^{(1)}$	EPG _{REP} ⁽²⁾	Biocom-Cov degree
United Kingdom	277,855	418.2	39,878	60.0	13,816	20.8	0.96	20	3
Spain	246,272	531.4	28,323	61.1	4,722	10.2	1.04	11	3
Italy	238,499	401.3	34,634	58.3	3,501	5.9	0.83	5	2
Germany	190,359	232.4	8,885	10.8	6,166	7.5	1.65	12	3
France	160,377	247.8	29,640	45.8	6,400	9.9	1.09	11	3
Belgium	61,156	538.4	9,589	84.4	1,339	11.8	1.16	14	3
Sweden	58,921	598.9	5,325	54.1	14,232	144.7	1.05	152	8
Netherlands	49,593	291.9	6,090	35.9	2,019	11.9	0.73	9	3
Portugal	39,133	377.3	1,530	14.8	4,640	44.7	1.14	51	5
Poland	31,931	83.5	1,356	3.5	5,370	14.0	0.98	14	3
Switzerland	31,209	364.2	1,679	19.6	327	3.8	1.33	5	2
Ireland	25,379	537.0	1,715	36.3	178	3.8	0.98	4	2
Romania	24,045	121.6	1,512	7.6	3,566	18.0	1.30	23	4
Austria	17,285	198.4	690	7.9	417	4.8	1.25	6	2
Denmark	12,391	216.9	600	10.5	443	7.8	1.07	8	2
Czech Republic	10,498	98.9	336	3.2	870	8.2	1.38	11	3
Norway	8,708	162.2	244	4.5	204	3.8	1.68	6	2
Finland	7,143	129.8	326	5.9	162	2.9	0.53	2	1
Luxembourg	4,120	715.3	110	19.1	81	14.1	1.52	21	3
Hungary	4,102	42.1	572	5.9	132	1.4	0.50	1	1
Bulgaria	3,905	54.8	199	2.8	1,178	16.5	1.17	19	3
Greece	3,266	29.2	190	1.7	269	2.4	1.55	4	2
Croatia	2,317	55.0	107	2.5	70	1.7	3.93	7	2
Estonia	1,981	151.0	63	4.8	42	3.2	0.59	2	1
Iceland	1,815	498.3	10	2.7	8	2.2	1.50	3	2
Lithuania	1,798	61.8	76	2.6	84	2.9	0.73	2	2
Slovakia	1,587	29.2	28	0.5	59	1.1	2.02	2	1
Slovenia	1,520	73.1	109	5.2	35	1.7	2.29	4	2
Latvia	1,111	56.4	30	1.5	23	1.2	2.23	3	2
Cyprus	986	84.3	19	1.6	22	1.9	0.28	1	1
Malta	664	154.8	9	2.1	33	7.7	NA	NA	1
Liechtenstein	83	215.3	1	2.6	0	0.0	NA	NA	0

Scale							
Worst	Worst	Worst	Worst	Worst	Worst	2.0	100
Best	Best	Best	Best	Best	Best	0.0	0

If we look at the table, we can clearly see that most countries have been always below Spanish incidence, we do not need to do a comparison with them. In this sense Spain opened earlier than most countries. Italy followed a similar process of reopening than Spain, with roughly the same dates, and the incidence was at least half. **However, there are three key countries which had clearly higher incidence than Spain at the end of June, Sweden and Portugal, and four with slightly higher once we consider the possibility of a lower detection rate, France, Belgium, Netherlands and Romania.**

Interestingly, Romania is one of the countries with a very high incidence right now, not that far from Spain. Very small changes could produce the small differences in timing between the two countries. Therefore, really interesting countries are thus Sweden, Poland, France, Belgium and Netherlands. We proceed to analyze these countries.

We must first address the cases of Sweden and Poland. Sweden never fully closed, so it never fully re-opened. It has followed a very different epidemiological path than Spain. Poland closed very early and it did not have a large first wave thanks to it, so it could reopen very early. Again, Poland has followed a very different path than Spain. The number of cumulative deaths in Sweden is roughly three times the one of Poland when Poland has close to 4 times the population of Sweden. We can observe **the evolution of cumulative (left) and daily new cases (right) of the three countries and how they are completely different.**

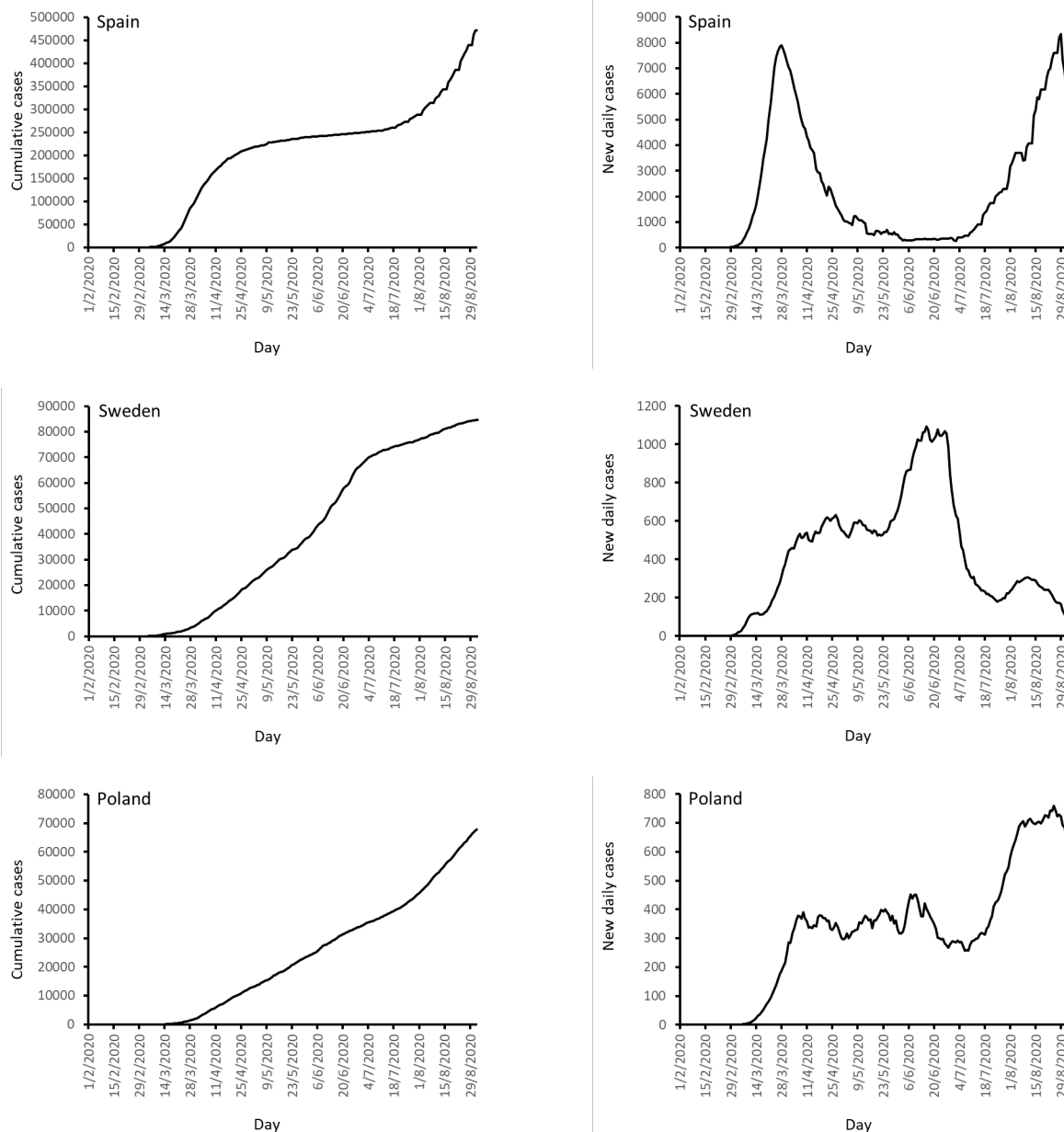


Figure 1. Cumulative (left) and daily new cases (right) in Spain, Sweden and Poland

During the last months, the incidence of Sweden reached different plateaus and mortality raised accordingly up to 60 deaths per 100,000 inh., the same one as Spain right now. Poland, on the other hand, has been increasing during the last weeks at lower constant rate always from low incidences. We must notice that cumulatively death cases in Sweden are the same position than Spain. Therefore, both countries are having completely different trajectories reaching different levels of mortality and incidence following a completely different part. **Direct comparisons are impossible given the different trajectories.** Having that in mind we should mention that while testing in Sweden is on the lower end of European countries with a peak capacity at 80 daily tests per 100,000 inh., the present basal level is low enough to control the epidemics through contact tracing. The epidemiological situation is better in Sweden than in Spain right now. The same can be said for Poland.

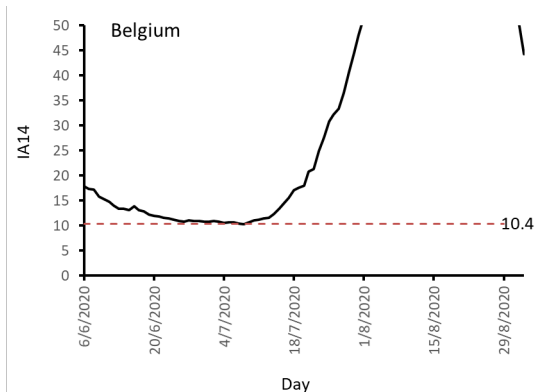
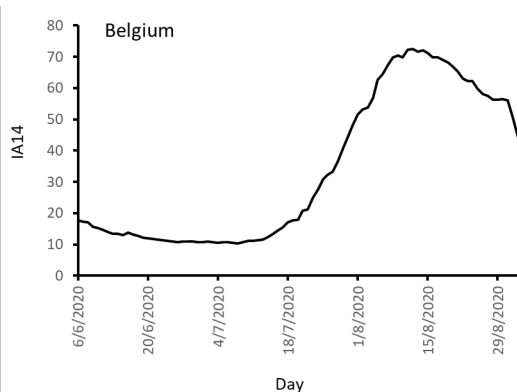
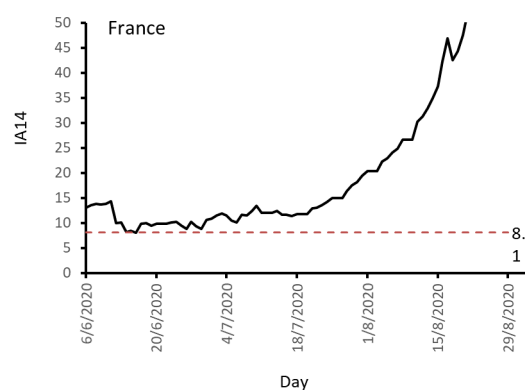
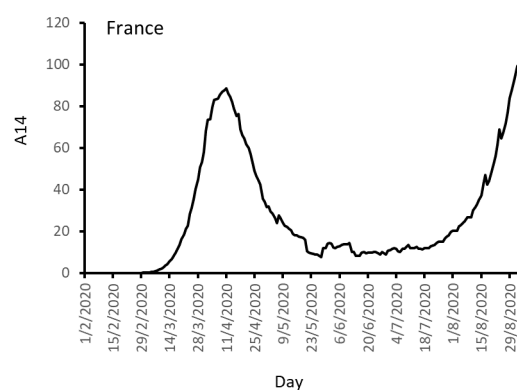
While Sweden and Poland can clearly not be compared with Spain, **France, Belgium and Netherland** do. All of them **have had roughly the same type of evolution** with a large first wave and then a stabilization. More importantly, in the present report we observe that new cases are also rising in France, Netherlands and

Belgium. In other words, **they are following exactly the same trajectory as Spain but with a delay**. The canary in the coal mine hypothesis does not fail here. It is thus important to recover the days that these countries reopened to check if they really had lower 14-day cumulative incidences on the key last dates of the reopening:

- France reopening key dates: Cafes/Restaurants opening on 15th of June ($A_{14} \approx 8/10^5$ inh.) with full reopening on the 11th of July ($12/10^5$).
- Belgium reopening key dates: Café bars reopening on 8th June ($19/10^5$), with full reopening of all activities, cinemas, pools on 1st July ($10/10^5$).
- Netherlands reopening key dates: Reopening of bars/restaurants on 1st June ($14/10^5$), with full opening of school and universities on 15th of June ($14/10^5$).

14-day cumulative incidence in Spain on 21st June (full reopening) was around 10 cases per 100,000 inh, which is close to the incidences of France, Belgium and Netherlands when they reopened as well.

It is also worth to compare the dynamics of 14-day cumulative incidence cases in these countries (next figure, left) together with the minimum incidences reached by them (next figure, right). It is interesting to see that the incidence in Netherlands still decreased for a while after the reopening, achieving the minimum A_{14} among these countries (around $5/10^5$), but that the four countries started increasing in July.



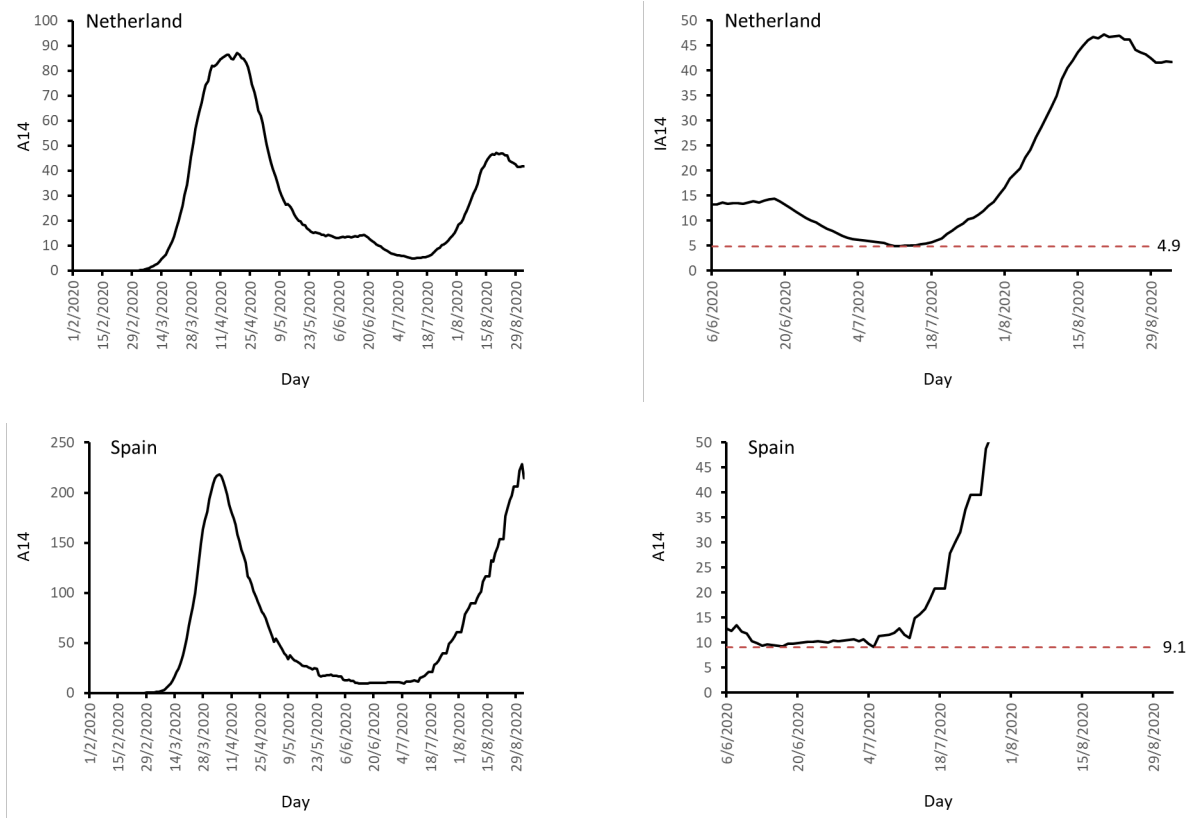


Figure 2. 14-day cumulative incidence cases in these countries (left) together with the minimum incidences reached by them (right).

Therefore, we conclude that this first hypothesis can explain the differences seen with most EU countries but not with all of them, if we are talking about reopening of the economy. We must notice, however, that **one thing is general reopening and another thing are particular reopenings**. For example, the reopening of **bars and restaurants** did indeed follow a very different path being quite advanced in Spain. At the beginning of May terraces were already open in most parts of Spain and restaurants had limitation but opened during the last week of May. In this sense Belgium, France and Netherlands may have effectively opened bars and restaurants later. If we only focus on particular activities, then the hypothesis would hold. This would mean that some features of the opening are crucial. In this sense, if the hypothesis we discuss is correct here, it would mean that bars and restaurants have a large effect on the epidemics. If this is not the case, then other effects must be taken into account. We will discuss them in the following reports.

Situation and trends in other countries

Table of current situation in other countries. Colour scale is indicated in each legend.

Country	Reported data						Indexes		
	Cumulative cases	Attack rate /10 ⁵ inh.	Cumulative deaths	Mortality /10 ⁵ inh.	Active cases (last 14 days)	14-day attack rate /10 ⁵ inh.	$p_7^{(1)}$	EPG _{REP} ⁽²⁾	Biocom-Cov degree
United States of America	6,075,652	1,835.5	184,689	55.8	593,236	179.2	1.01	180	8
Brazil	3,950,931	1,858.7	122,596	57.7	543,577	255.7	1.08	276	9
India	3,769,523	278.6	66,333	4.9	1,002,250	74.1	1.11	82	6
Russia	1,000,048	685.3	17,299	11.9	67,555	46.3	1.01	47	5
Peru	657,129	1,993.0	29,068	88.2	107,808	327.0	0.93	305	9
Mexico	606,036	470.0	65,241	50.6	74,797	58.0	1.01	59	6
Argentina	417,722	924.3	8,730	19.3	118,609	262.4	1.23	322	9
Chile	413,145	2,161.2	11,321	59.2	24,290	127.1	1.01	128	8
Iran	376,894	448.7	21,672	25.8	29,059	34.6	1.16	40	5
Saudi Arabia	316,670	909.6	3,929	11.3	15,337	44.1	0.87	38	5
Pakistan	296,590	134.3	6,318	2.9	6,758	3.1	0.70	2	2
Canada	129,425	342.9	9,132	24.2	6,271	16.6	1.14	19	3
Qatar	118,994	4,130.2	198	6.9	3,333	115.7	0.85	98	7
Ecuador	114,309	647.9	6,571	37.2	11,368	64.4	0.99	64	6
Belarus	71,962	761.6	686	7.3	2,289	24.2	1.07	26	4

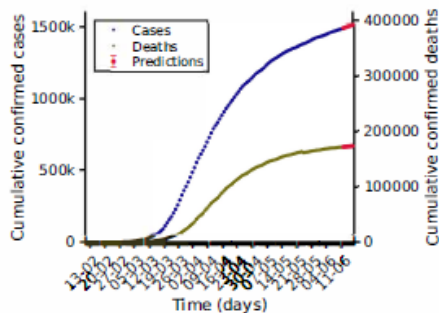
Scale							
Worst	Worst	Worst	Worst	Worst	Worst	2.0	100
Best	Best	Best	Best	Best	Best	0.0	0

⁽¹⁾ p_7 is the average of 7 consecutive p , but can still fluctuate. ⁽²⁾ EPG_{REP} stands for Effective Growth Potential, which is the product of reported cumulative incidence of last 14 days per 10⁵ inhabitants by p_7 (empiric reproduction number). Biocom-Cov degree is an epidemiological situation scale based on the level of last week's mean daily new cases (<https://upcommons.upc.edu/handle/2117/189661>, <https://upcommons.upc.edu/handle/2117/189808>).

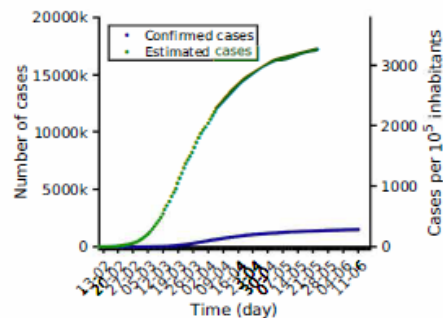
Legend: Countries' reports details

EU+EFTA+UK 11-06-2020. Population: 527.9M. Current cum. incidence: 283/10⁵

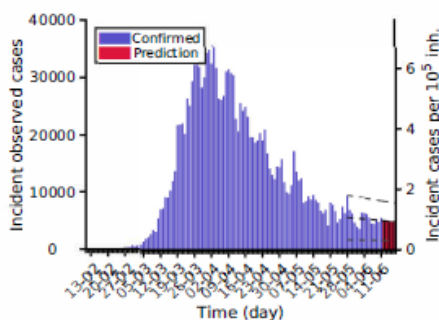
Reported cumulative cases (blue) and deaths (brown), together with predictions (red)



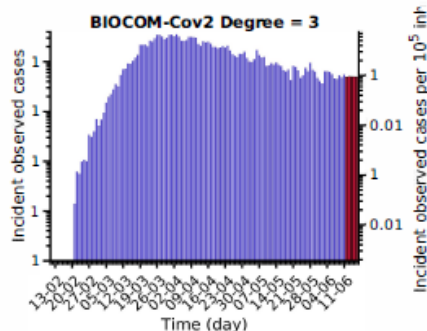
Estimated and reported cases.



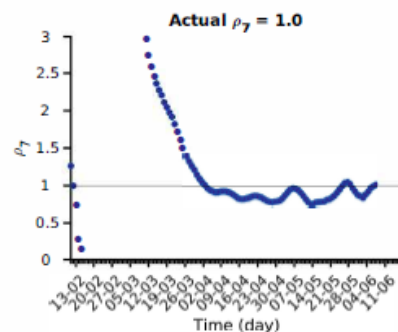
Incident observed cases and predictions.



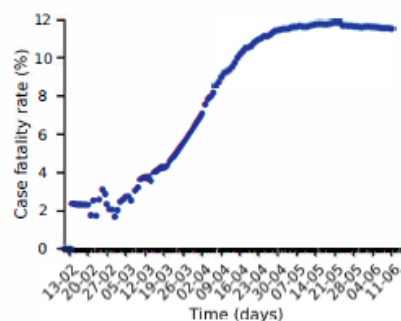
Incident observed cases in a logarithmic scale, with Biocom-Cov degree.



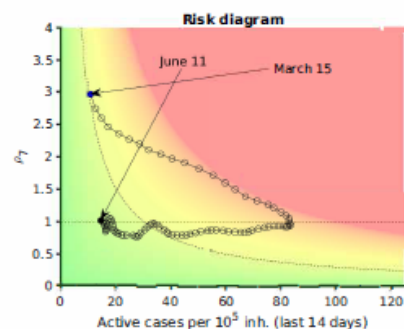
Evolution of empiric reproductive number ρ_T



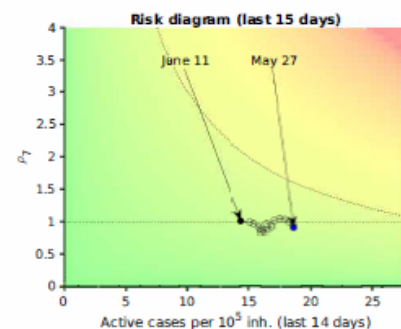
Case fatality rate



Risk diagram

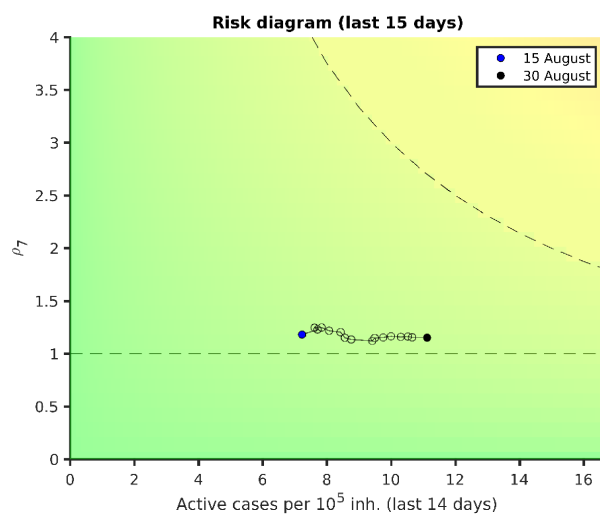
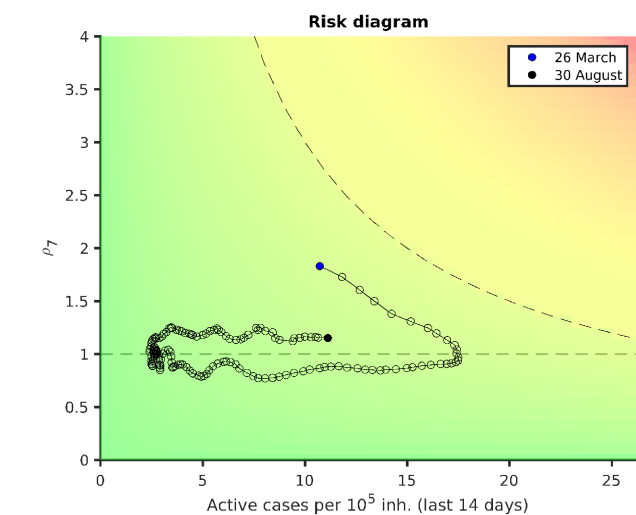
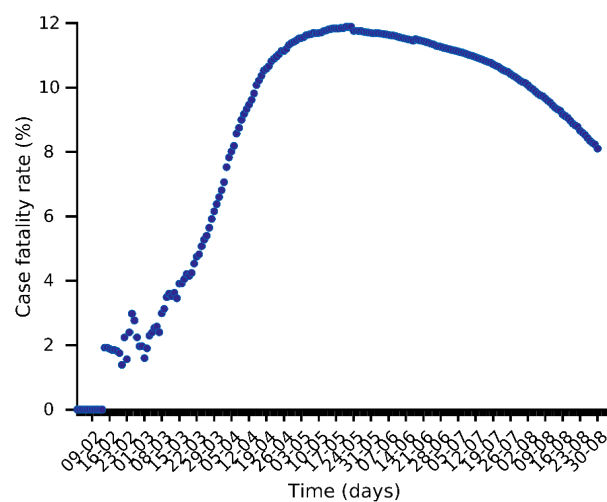
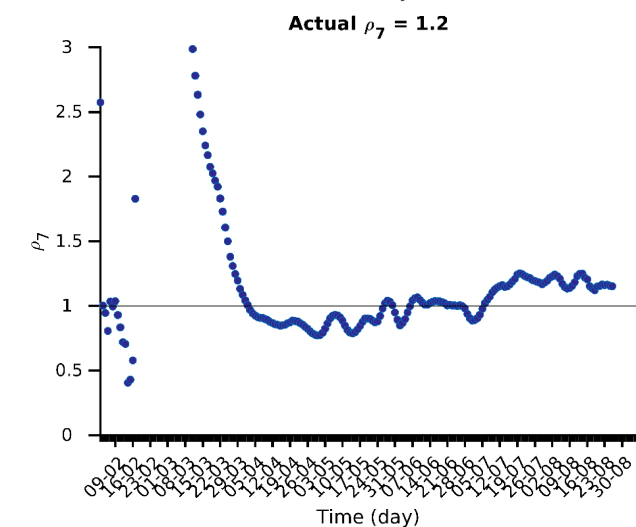
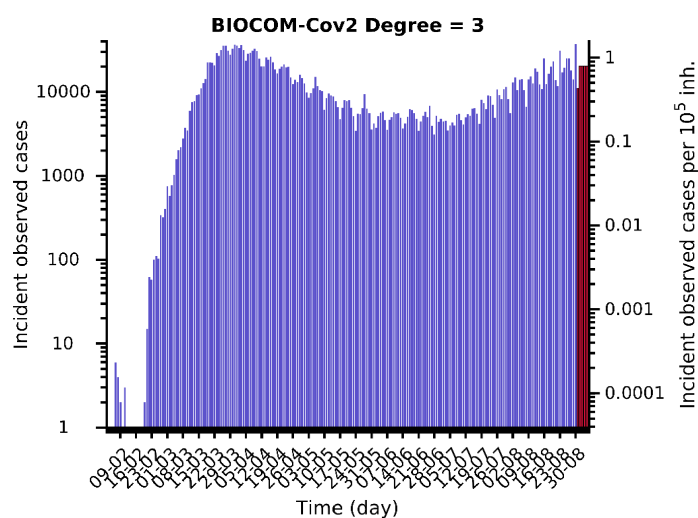
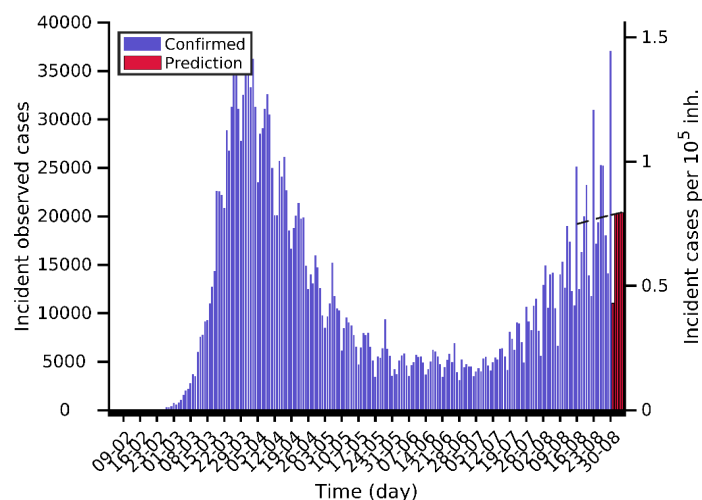
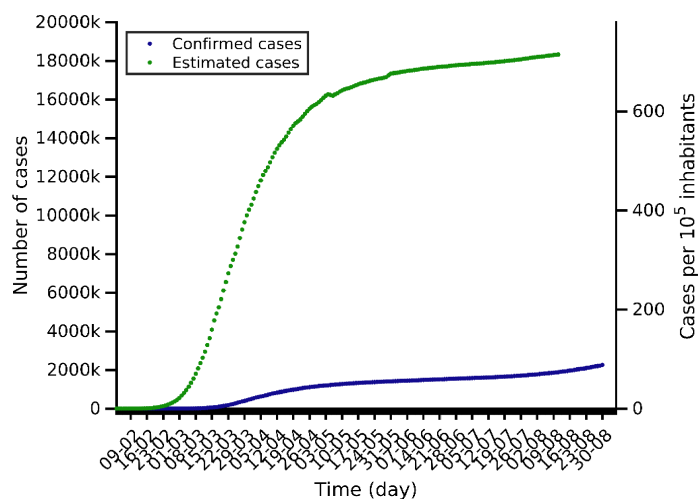
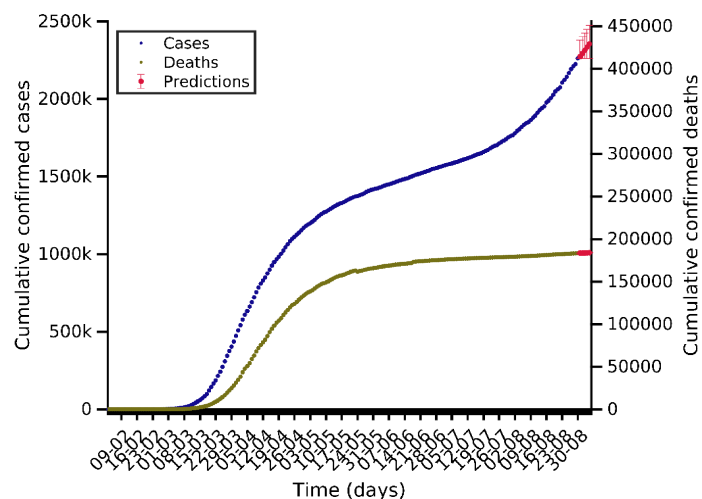


Risk diagram of last 15 days

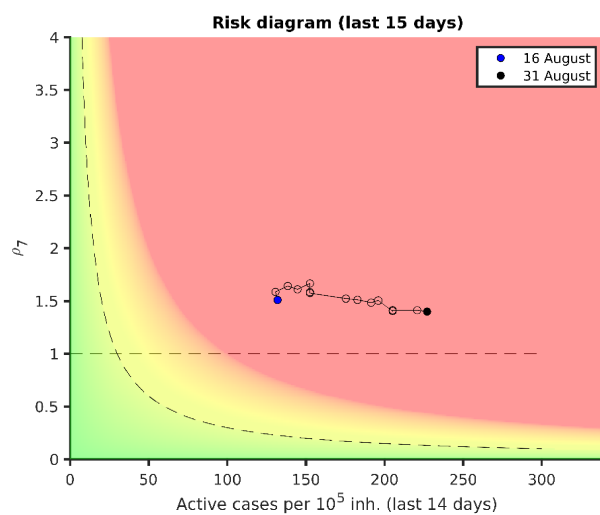
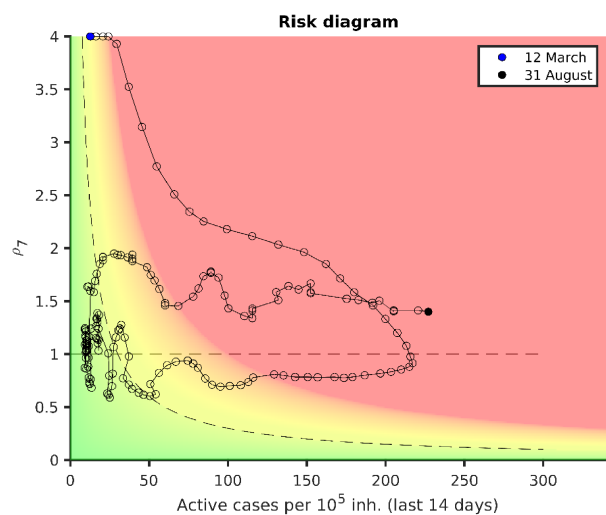
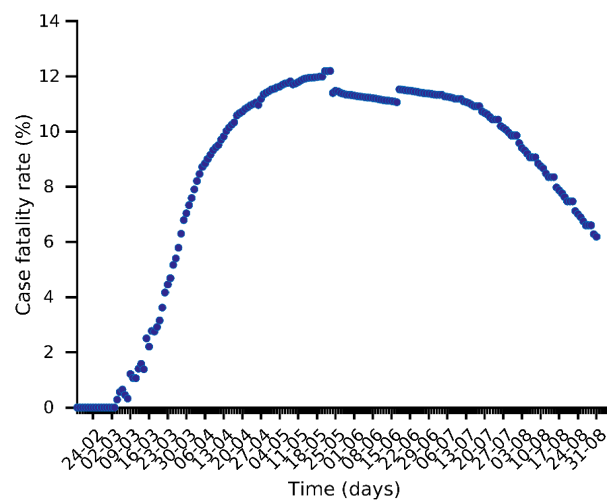
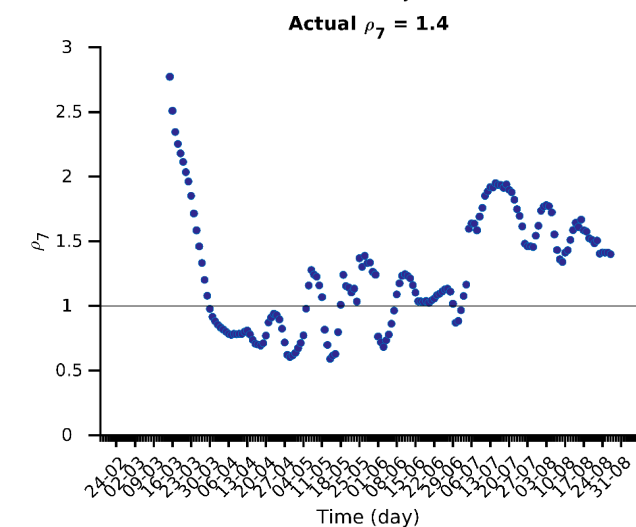
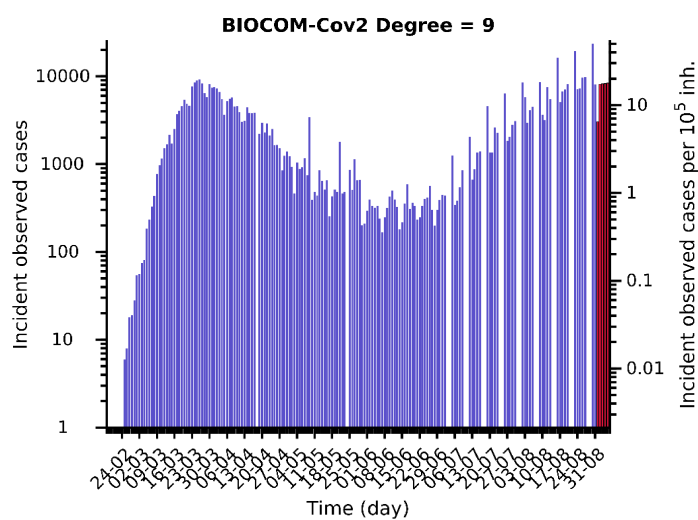
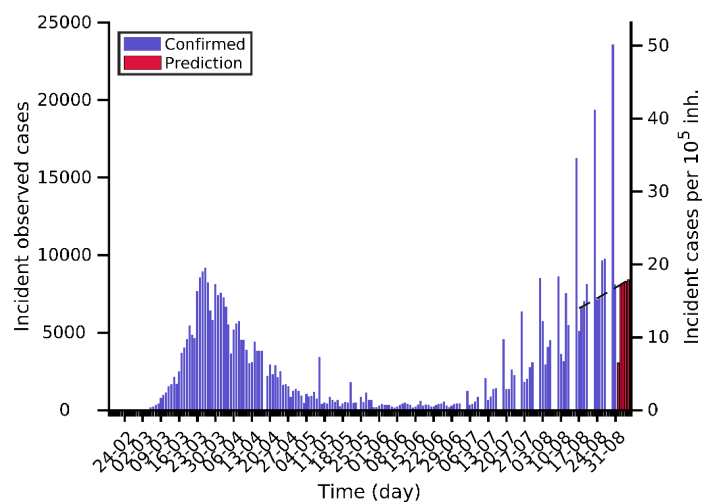
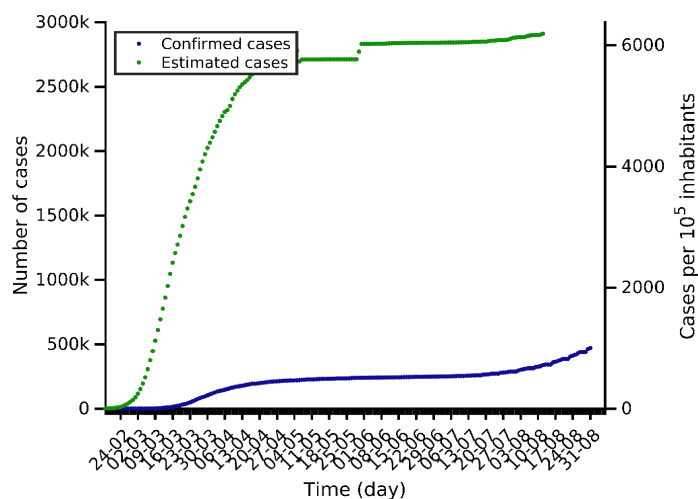
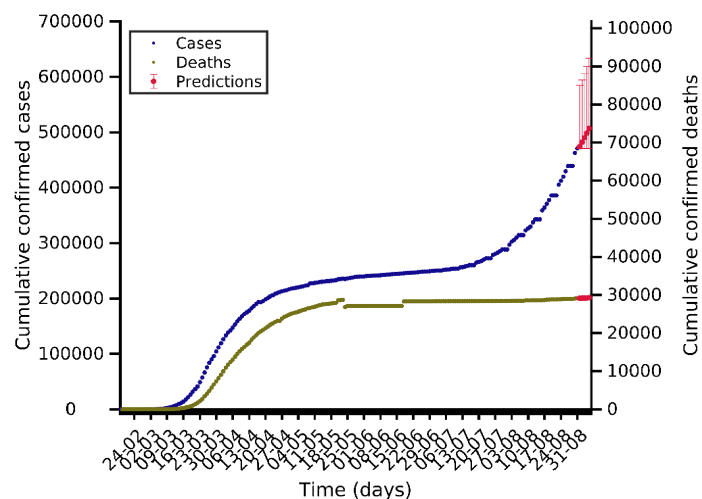


**(1) Analysis and prediction of COVID-19
for EU+EFTA+UK**

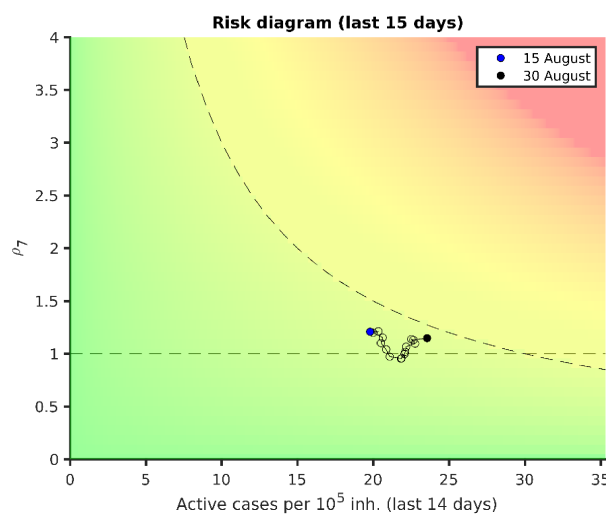
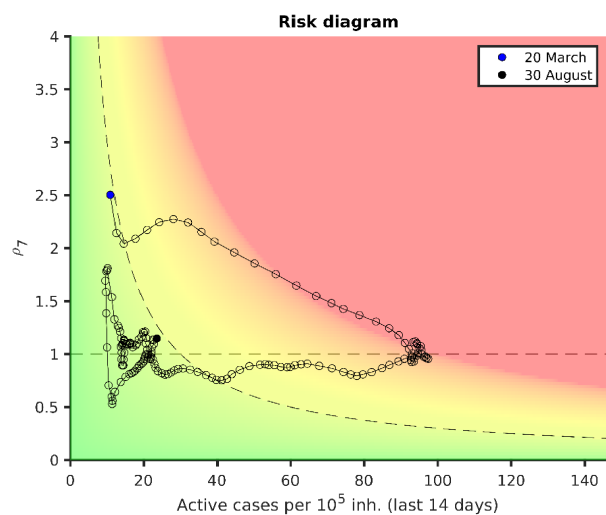
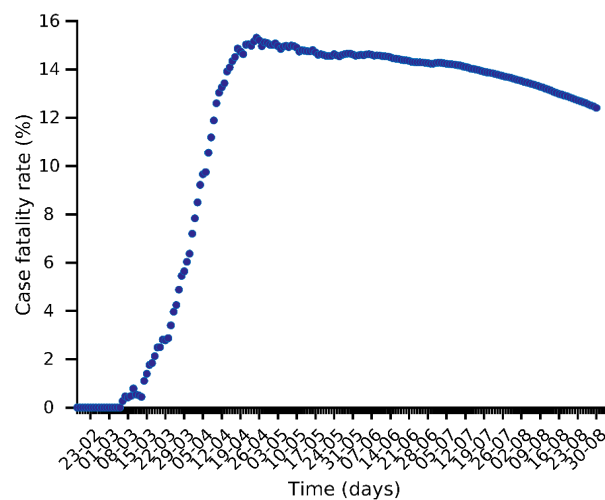
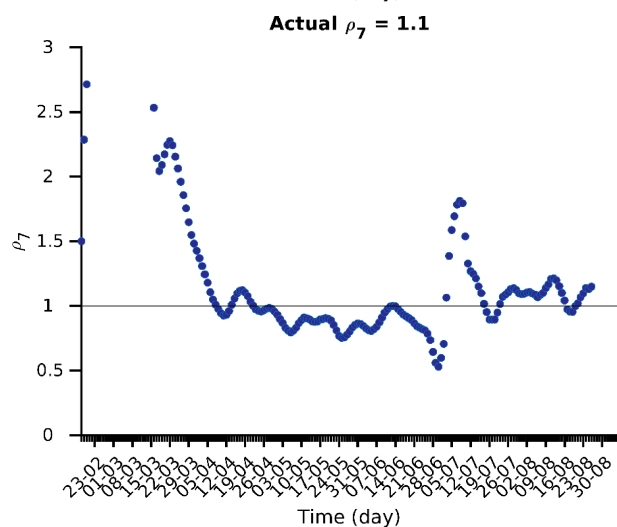
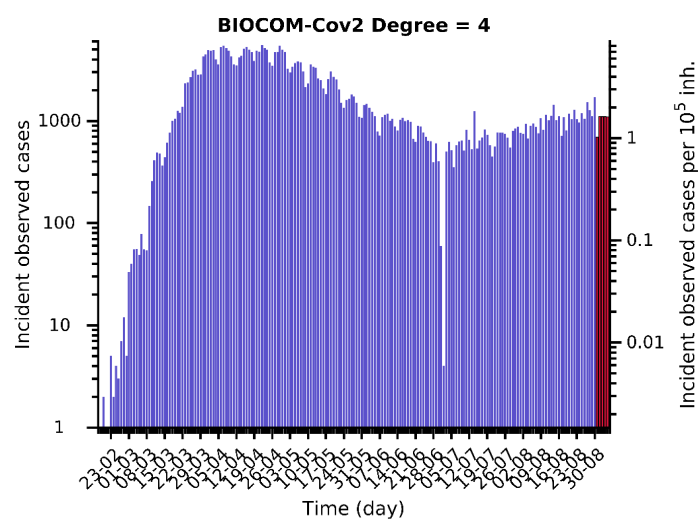
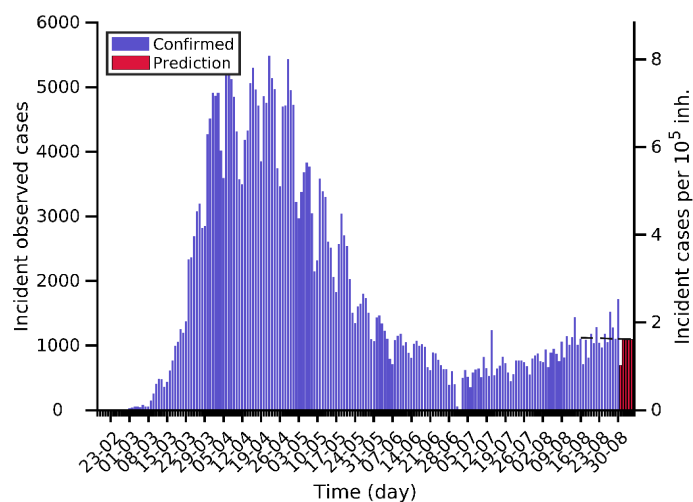
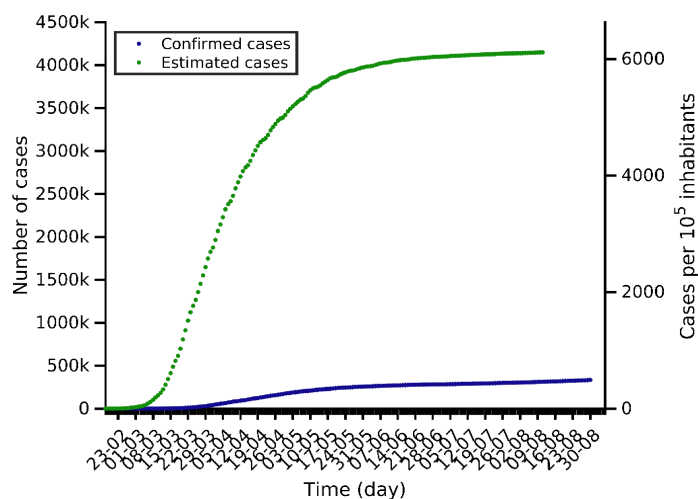
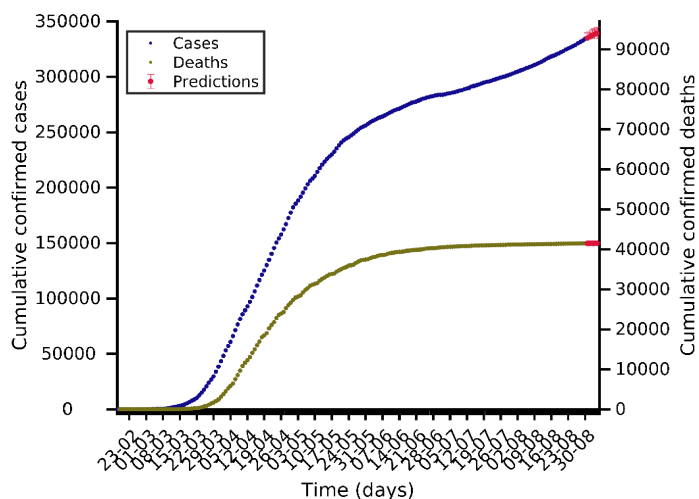
EU+EFTA+UK 30-08-2020. Pop: 2564.4M. Cumulative incidence: 88/10⁵



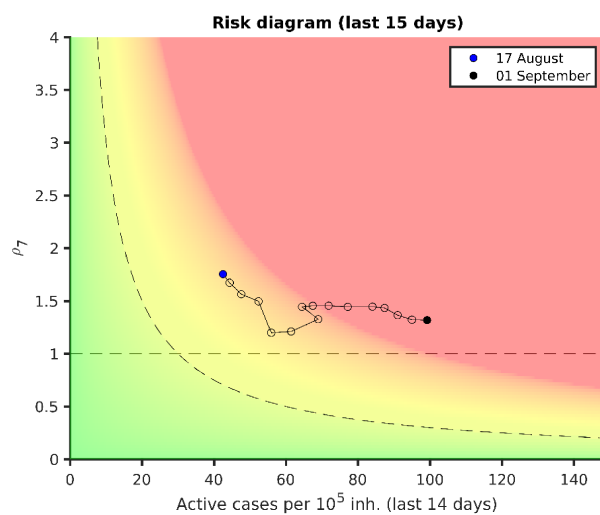
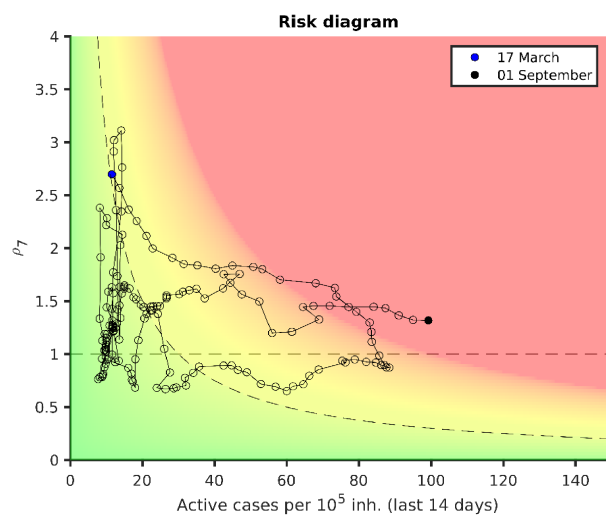
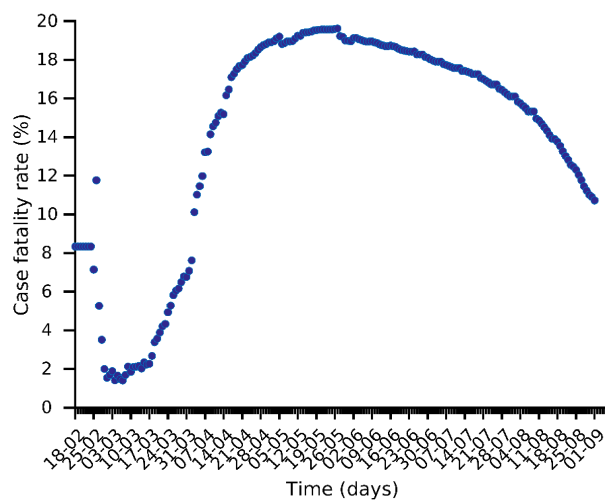
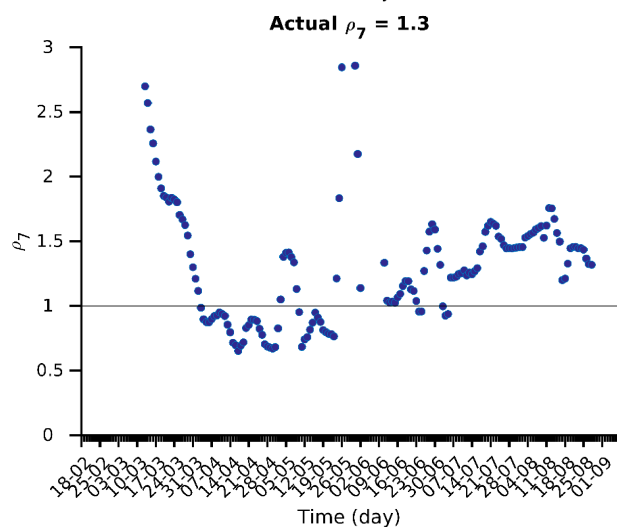
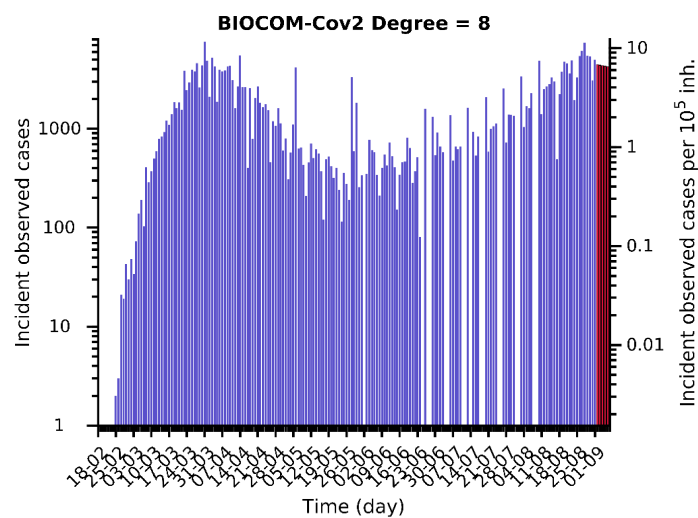
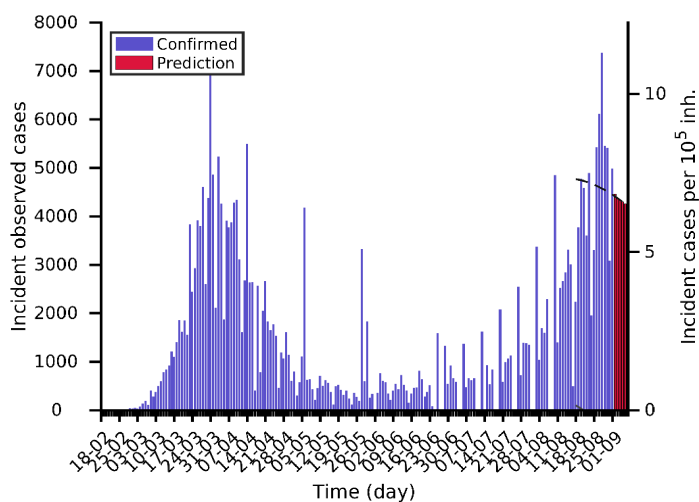
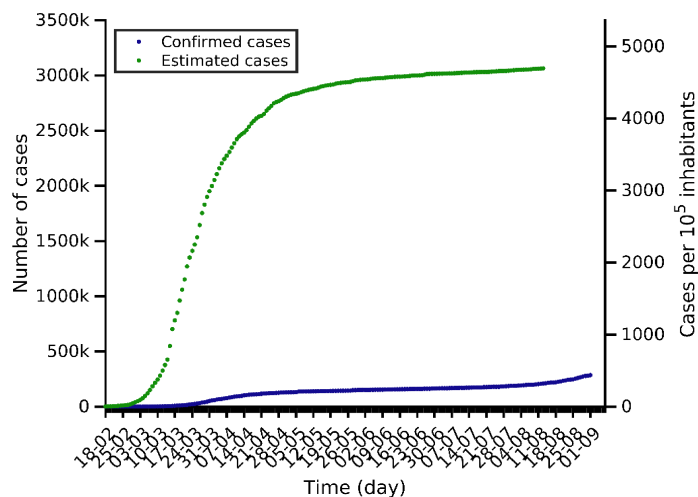
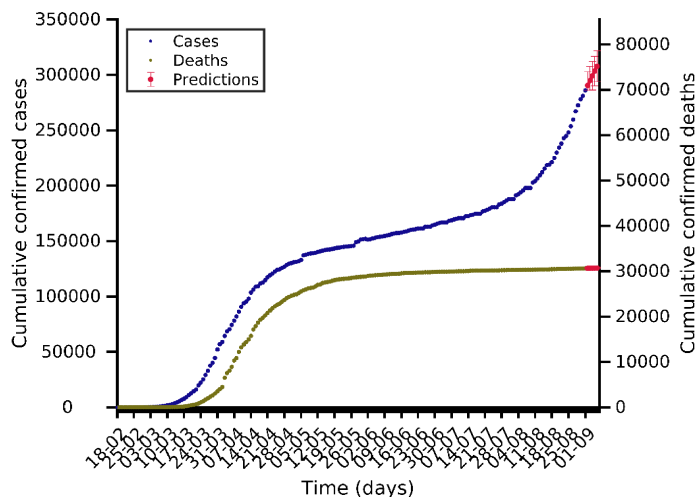
Spain 31-08-2020. Pop: 47.0M. Cumulative incidence: 1002/10⁵



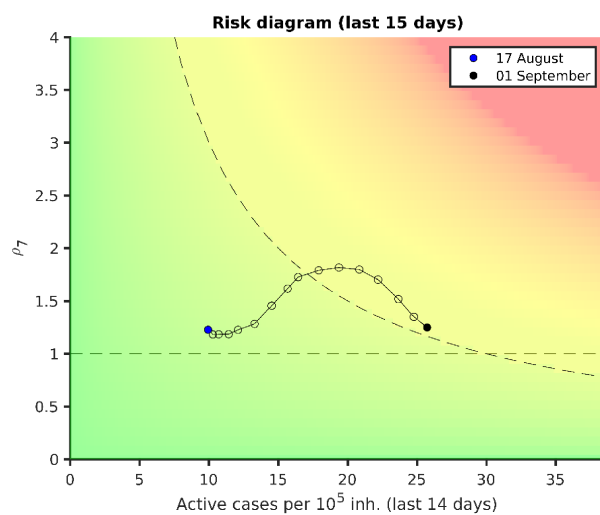
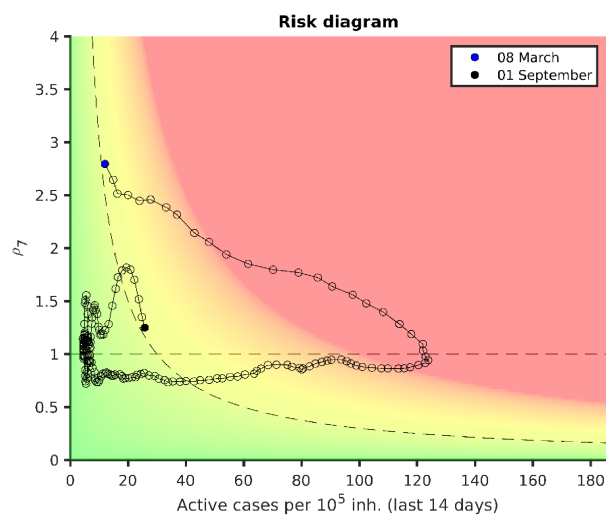
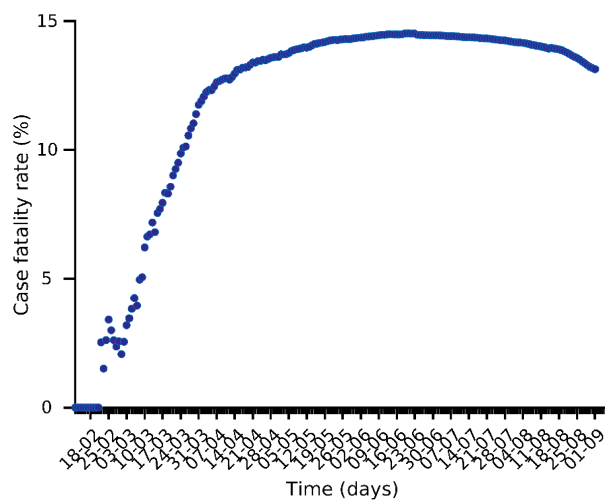
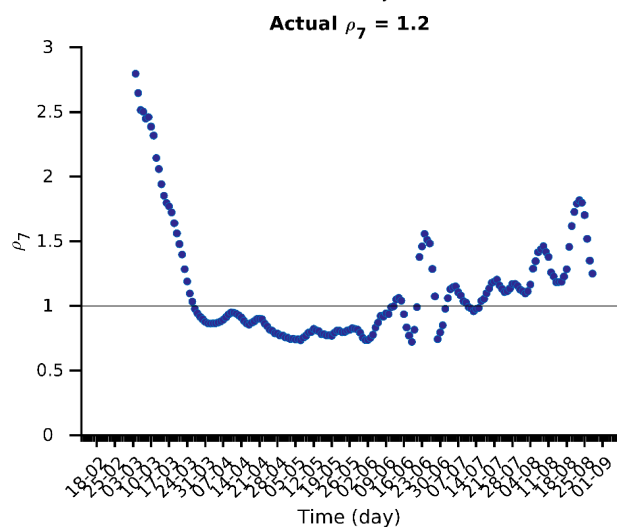
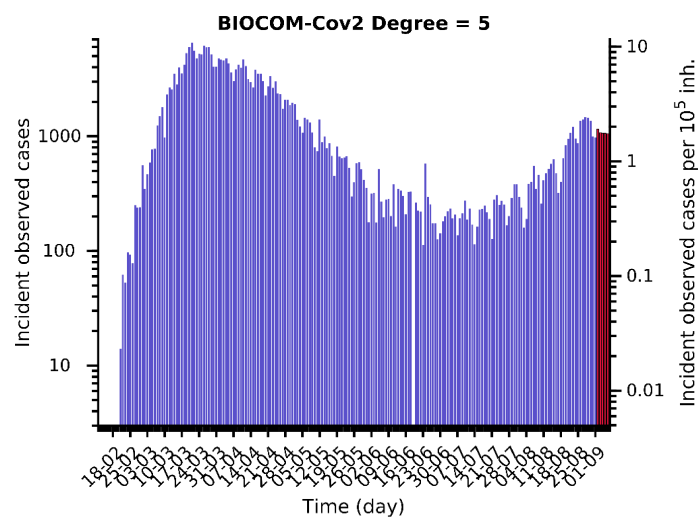
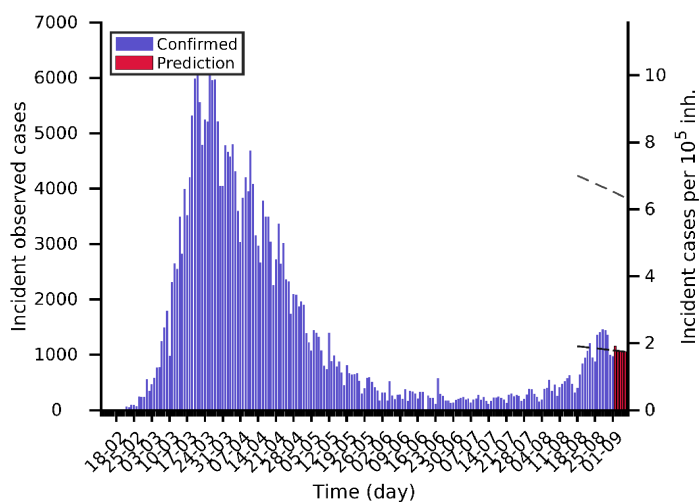
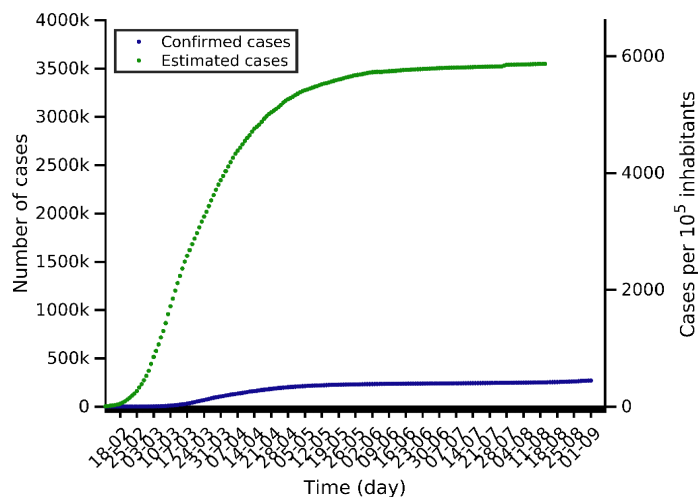
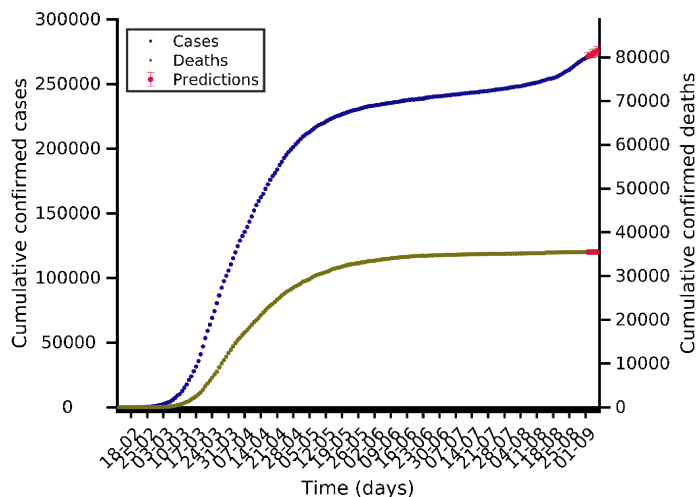
UK 30-08-2020. Pop: 67.9M. Cumulative incidence: 493/10⁵



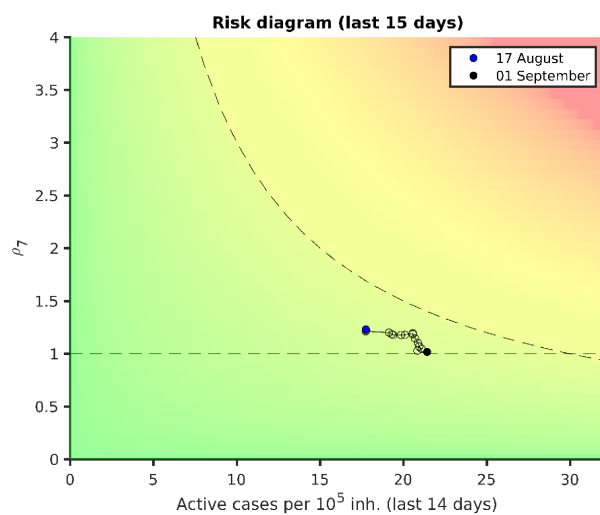
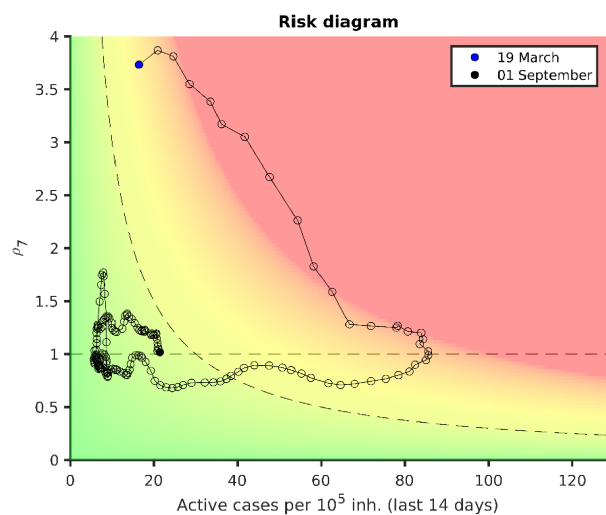
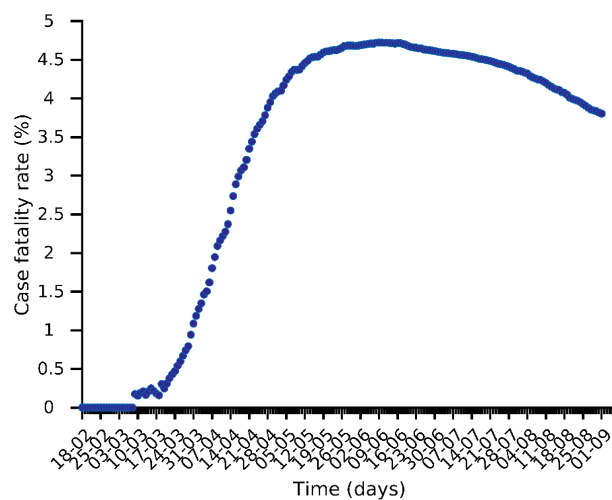
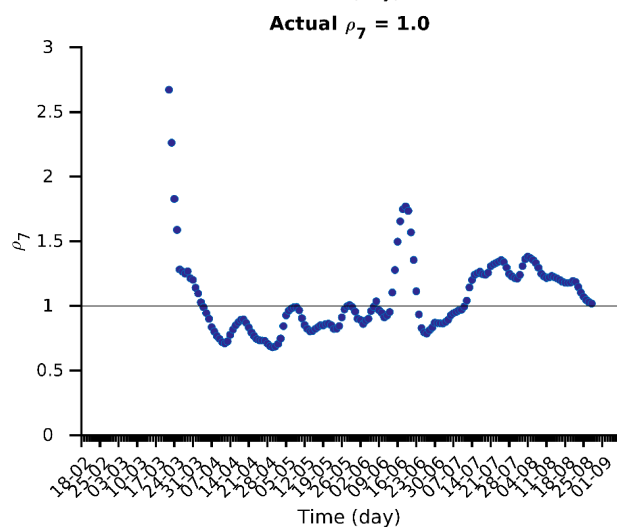
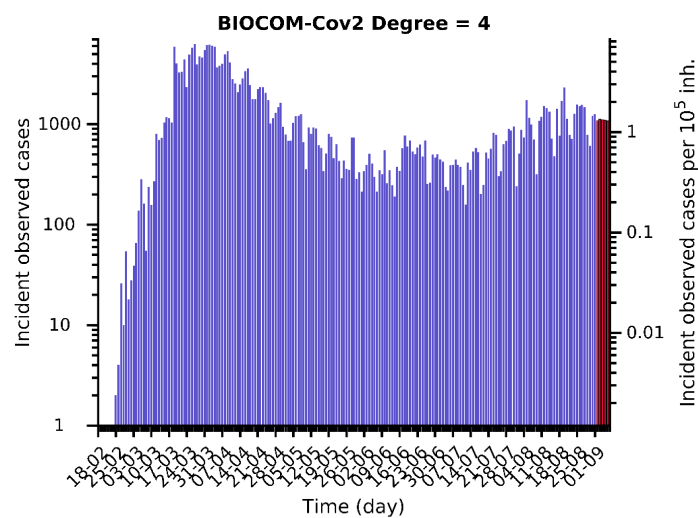
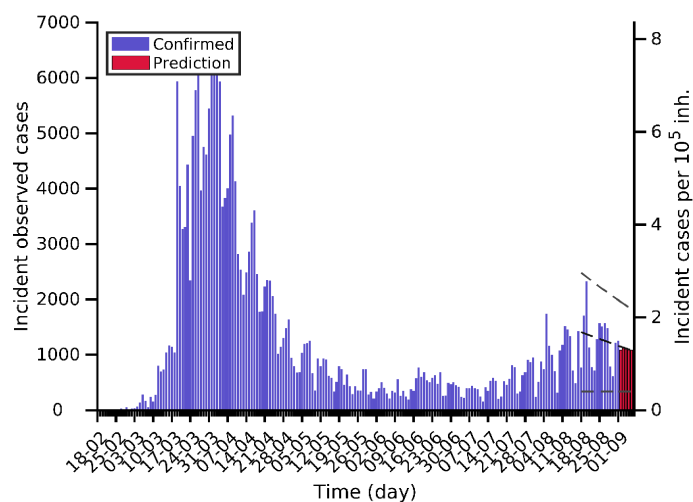
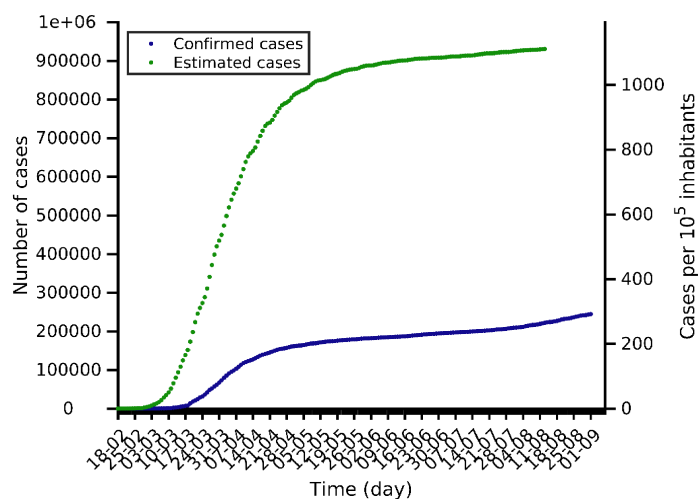
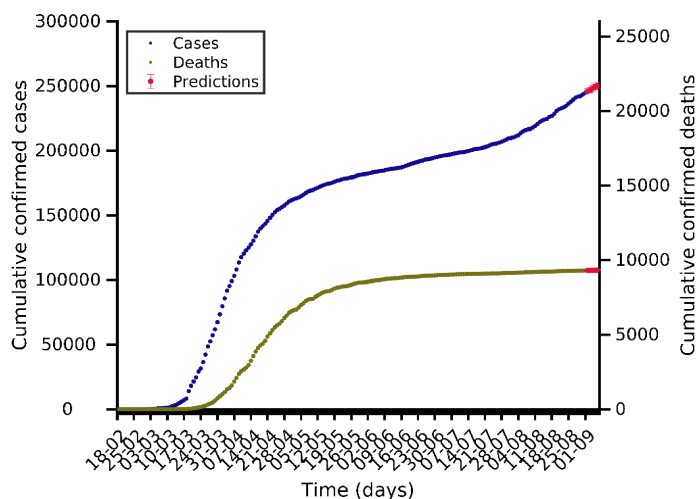
France 01-09-2020. Pop: 65.3M. Cumulative incidence: 438/10⁵



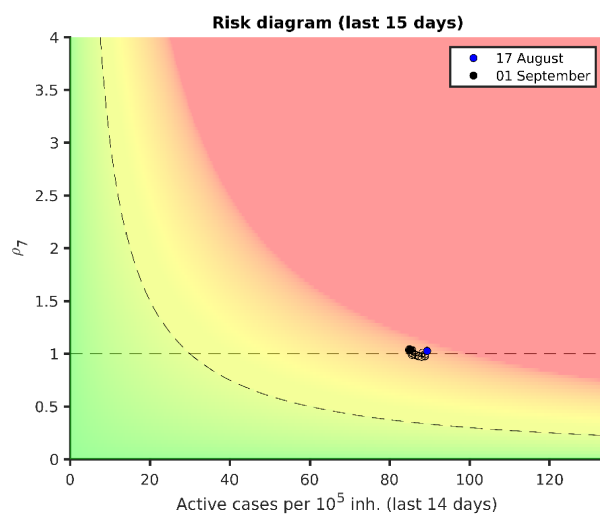
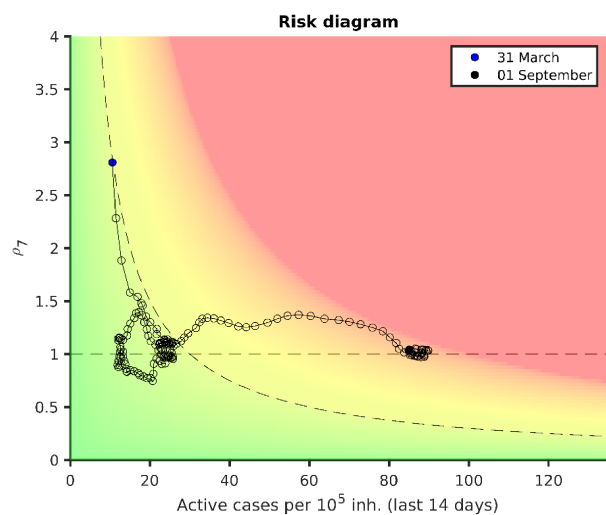
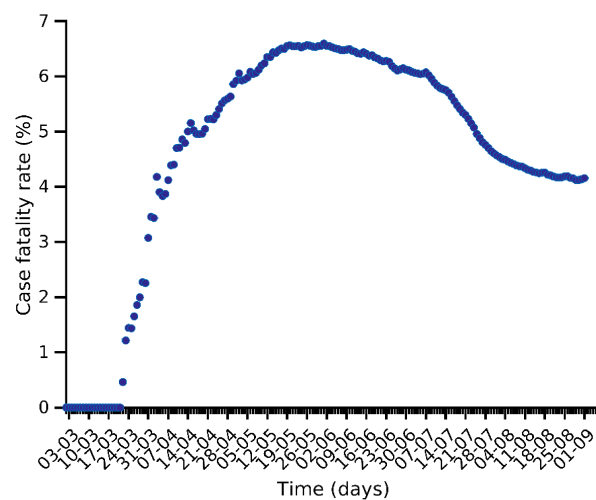
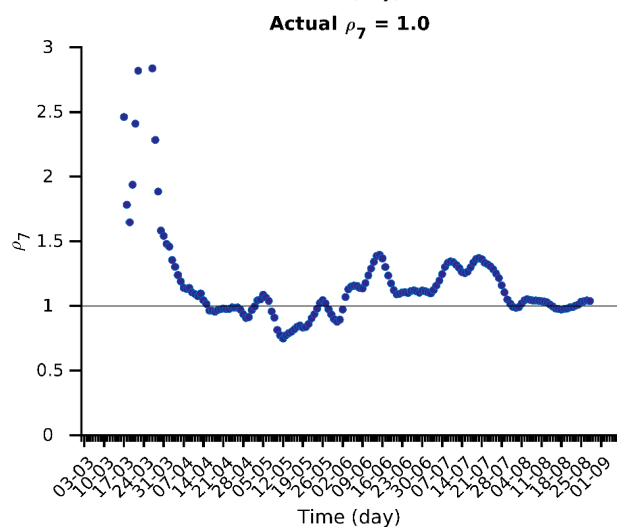
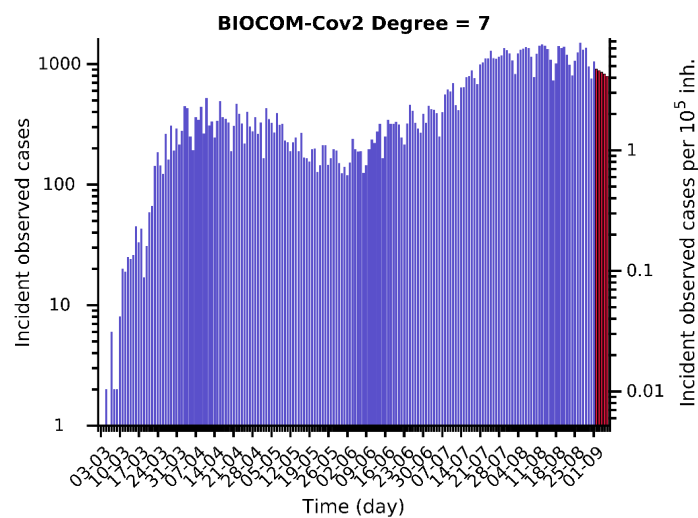
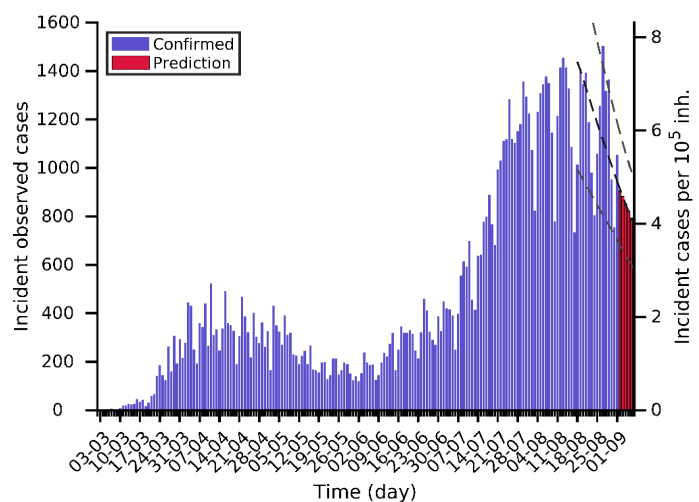
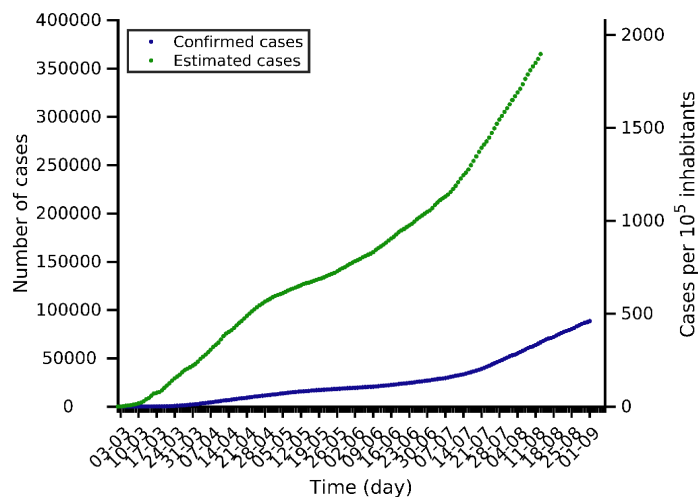
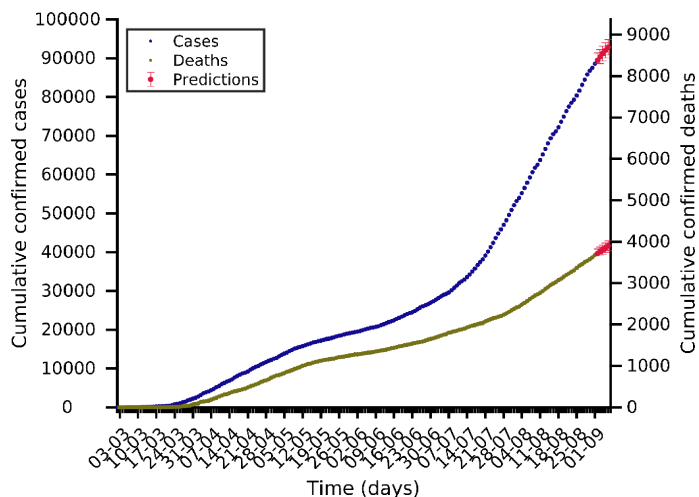
Italy 01-09-2020. Pop: 60.5M. Cumulative incidence: 447/10⁵



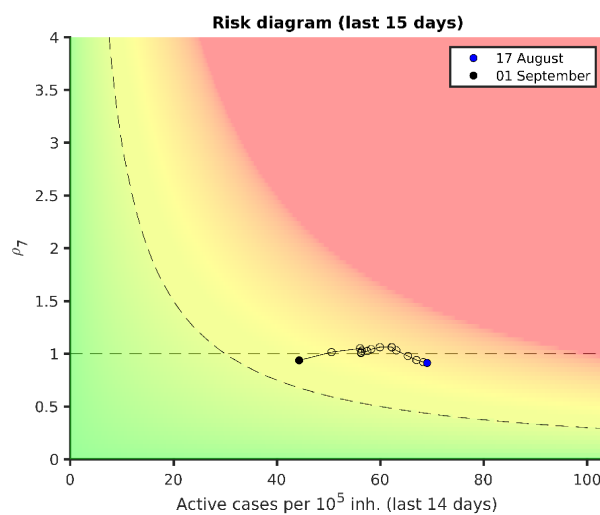
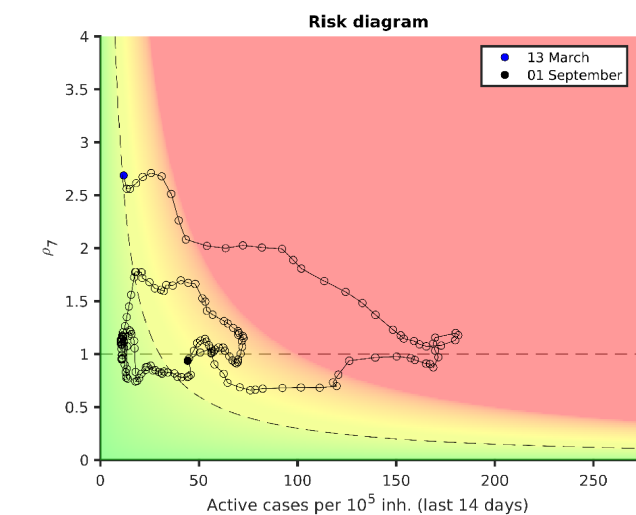
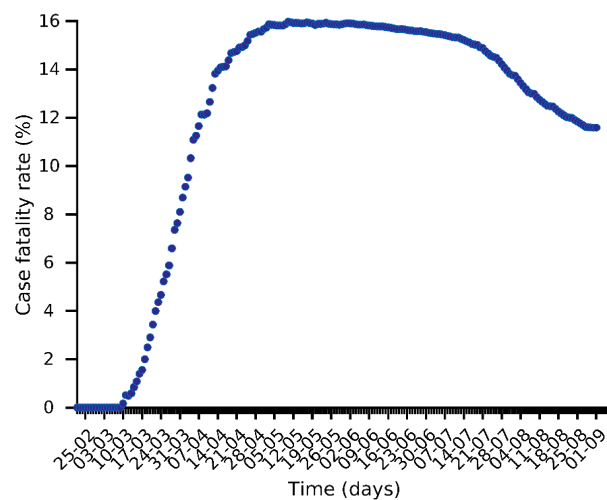
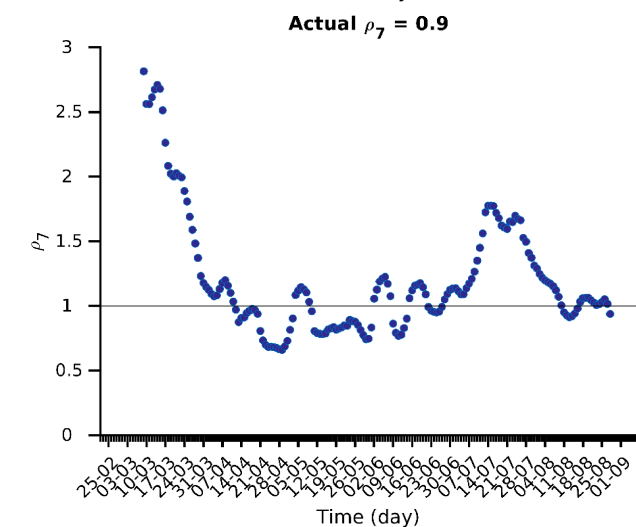
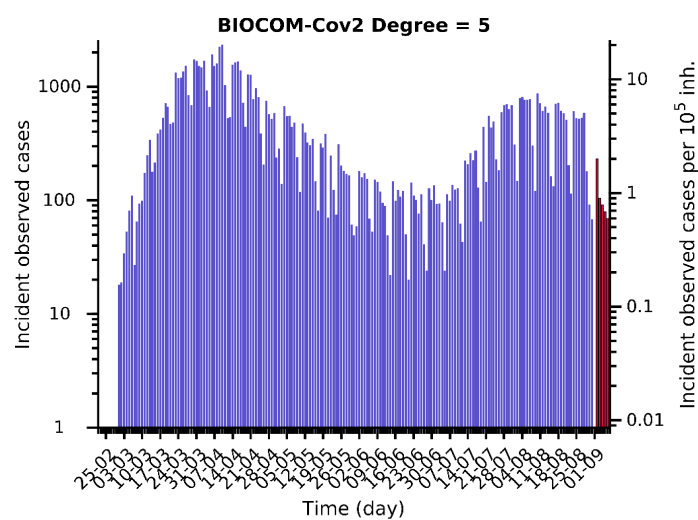
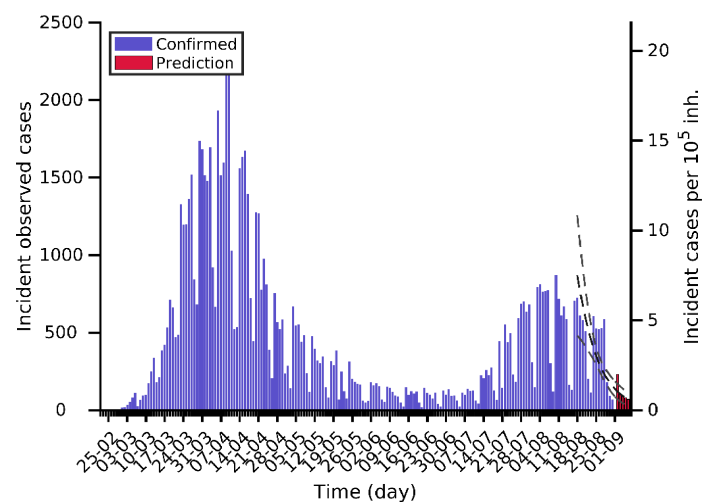
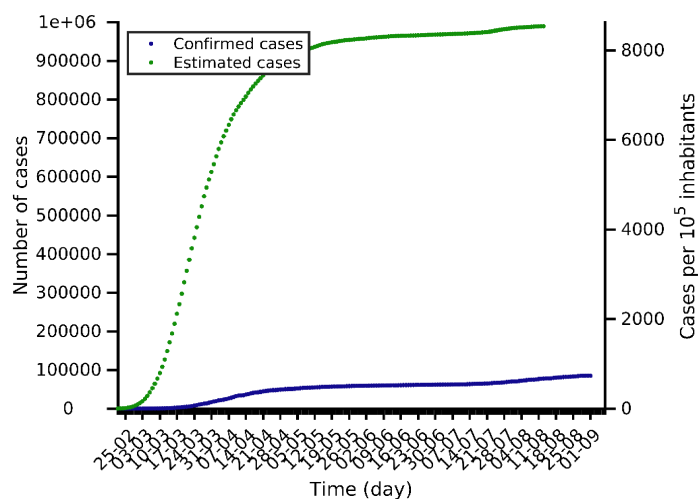
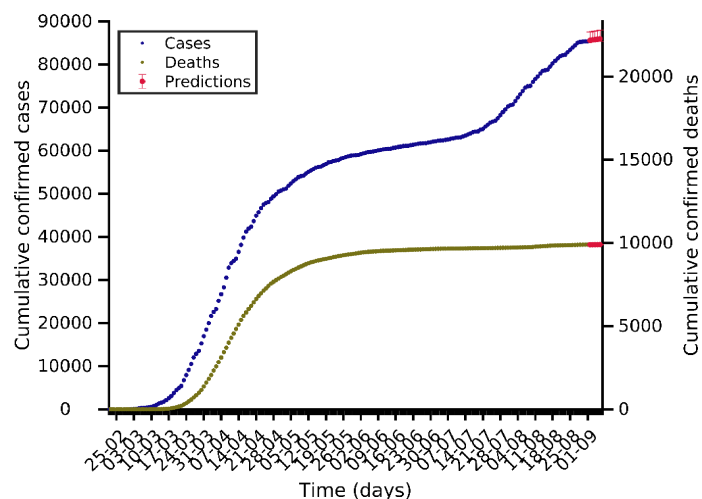
Germany 01-09-2020. Pop: 83.8M. Cumulative incidence: 292/10⁵



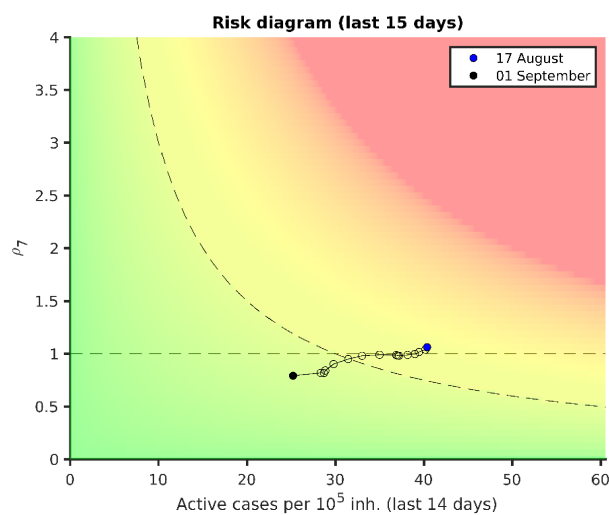
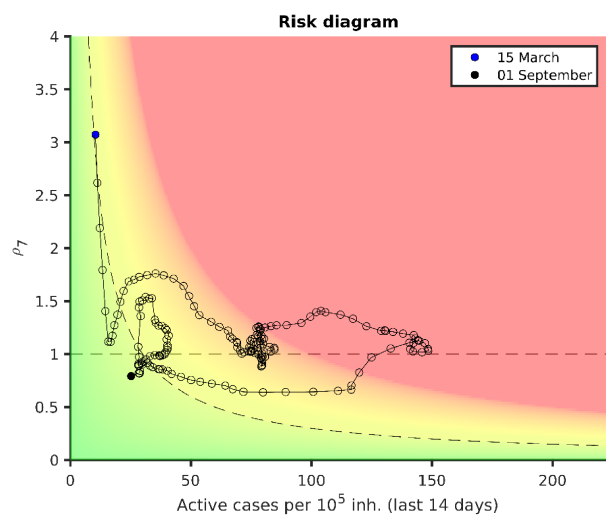
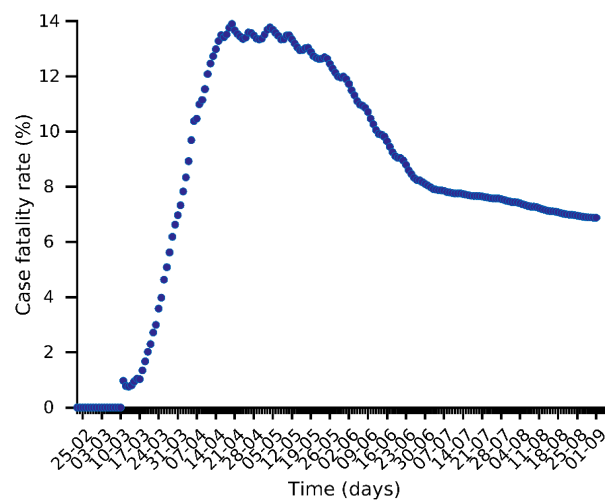
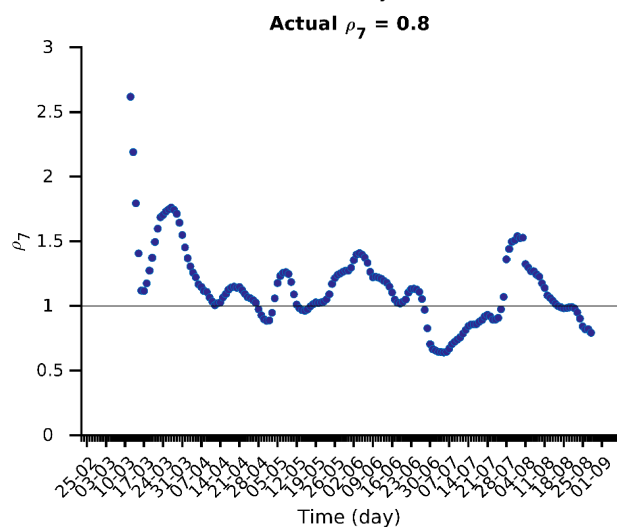
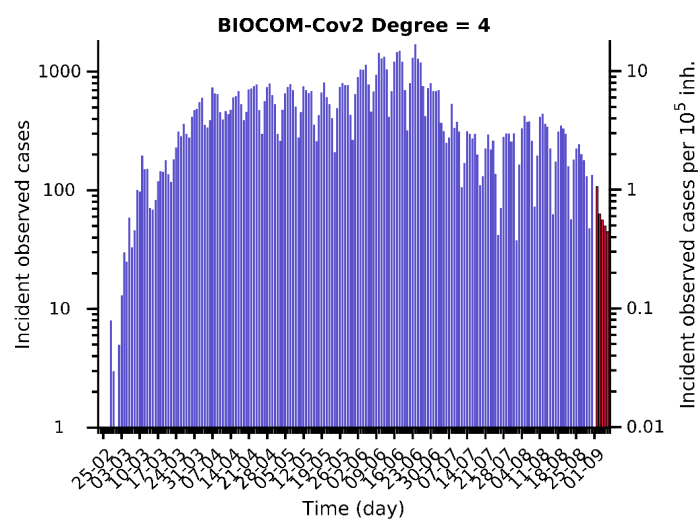
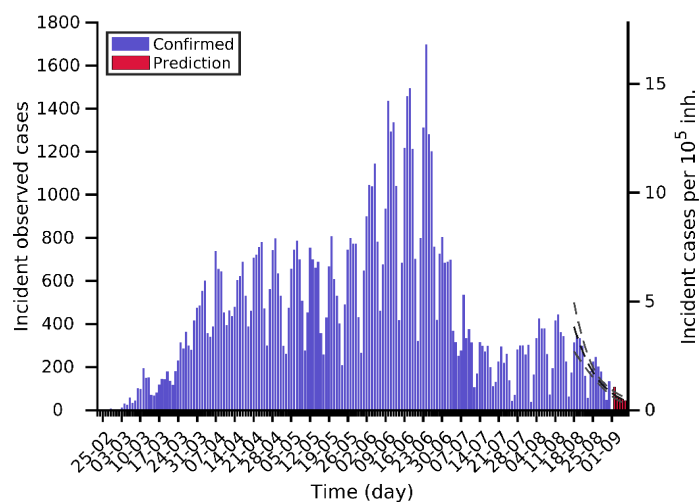
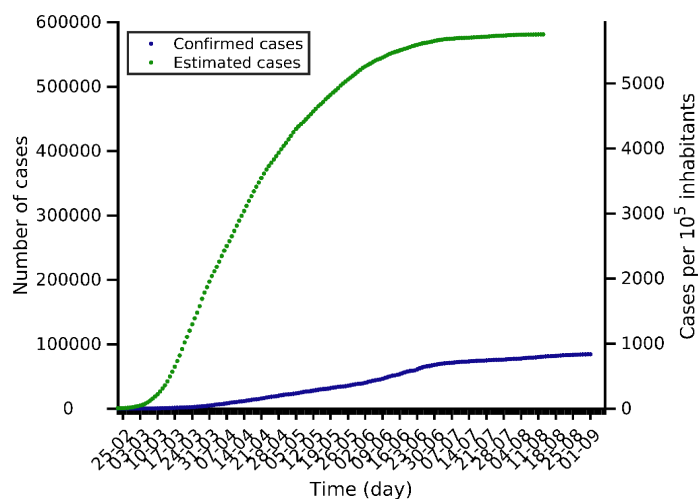
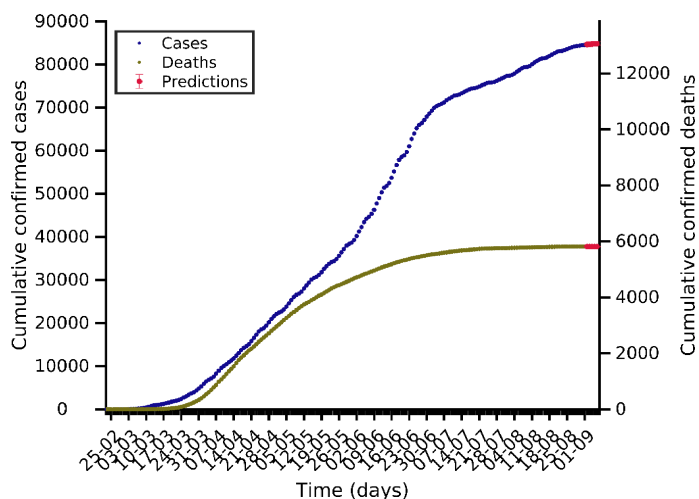
Romania 01-09-2020. Pop: 19.2M. Cumulative incidence: 461/10⁵



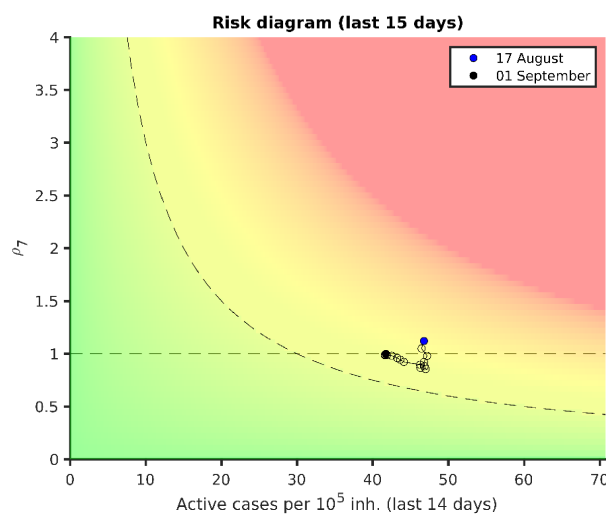
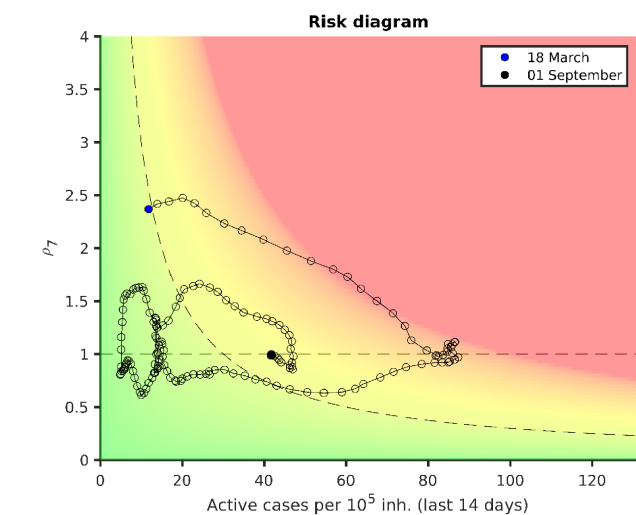
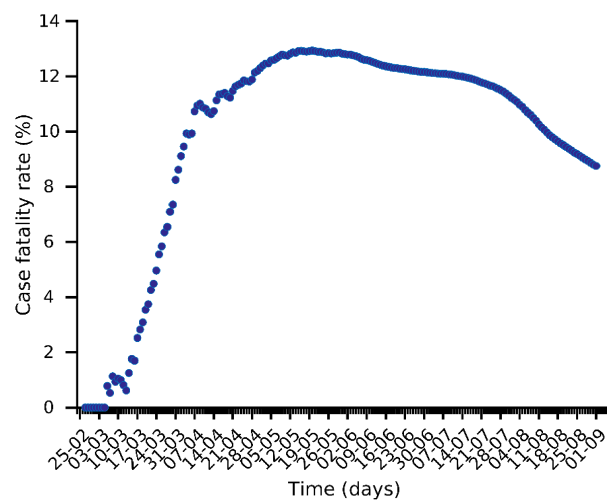
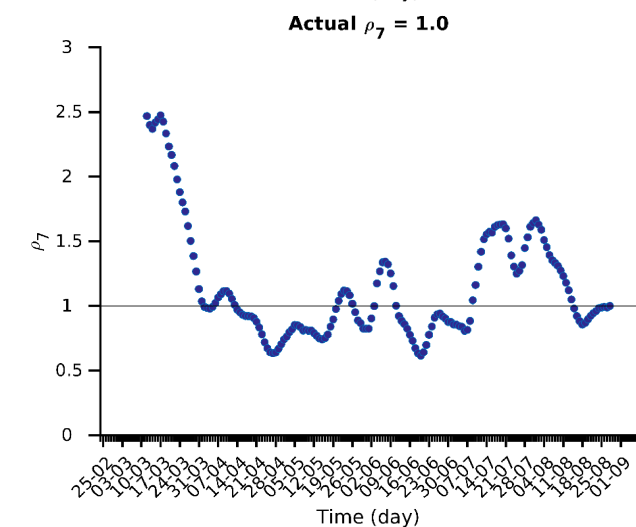
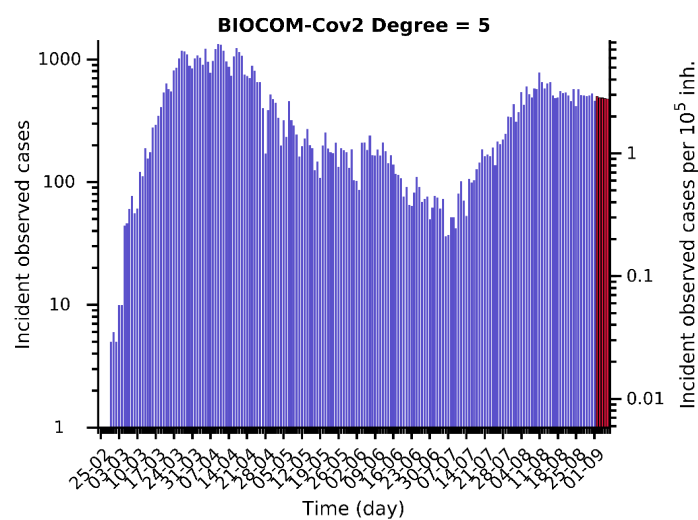
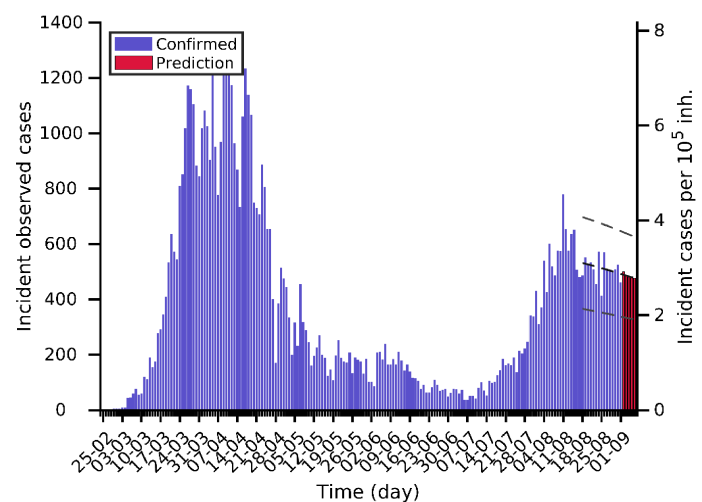
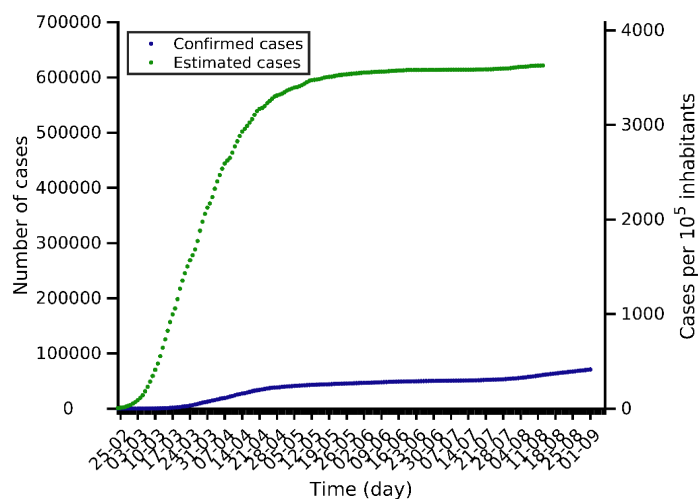
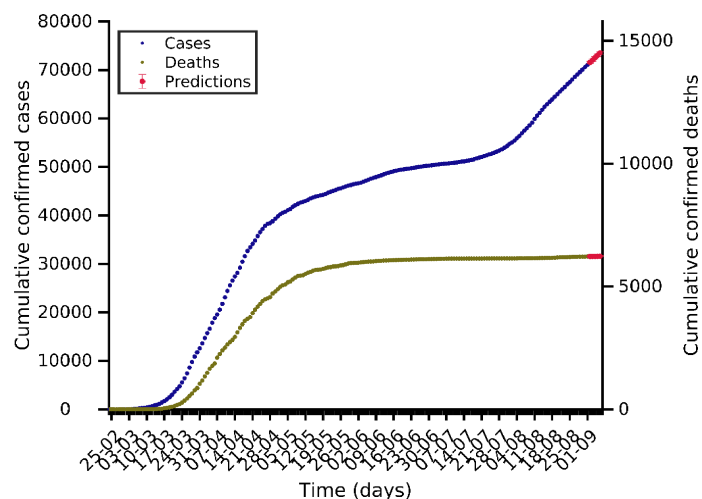
Belgium 01-09-2020. Pop: 11.6M. Cumulative incidence: 737/10⁵



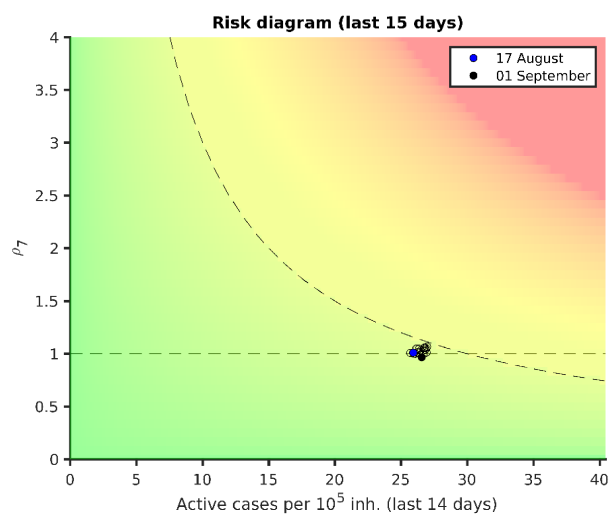
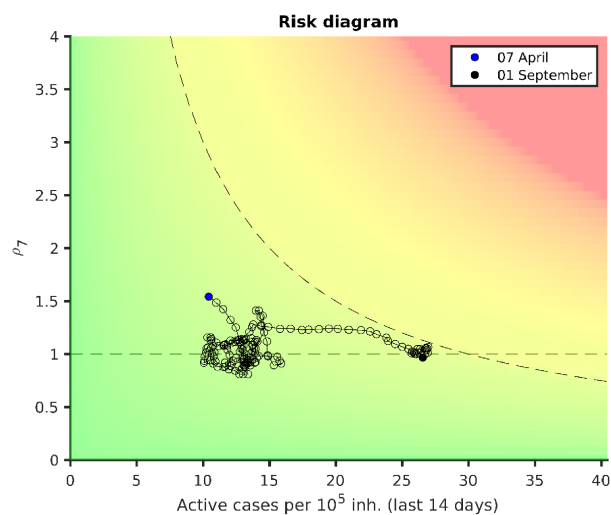
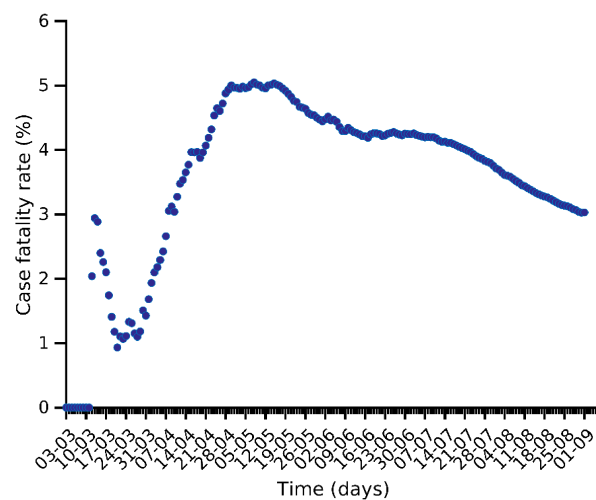
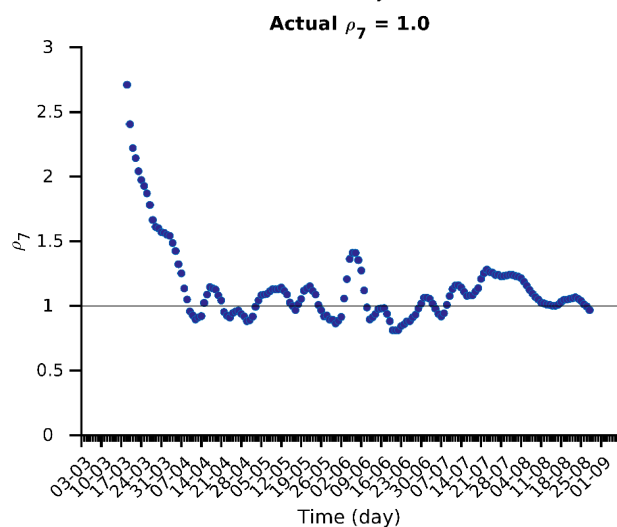
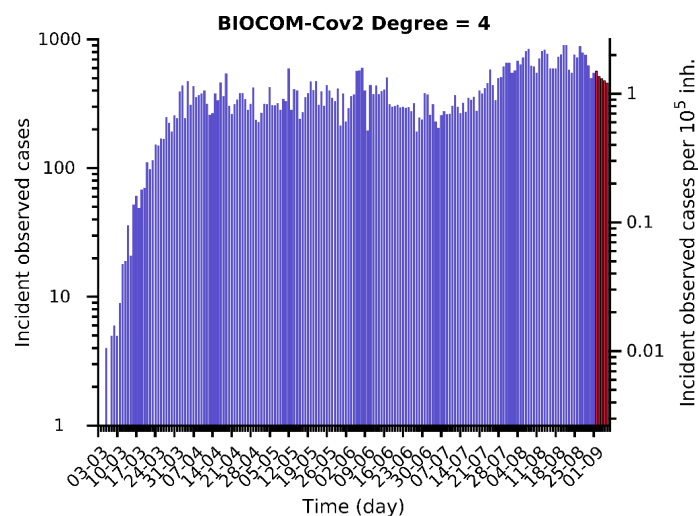
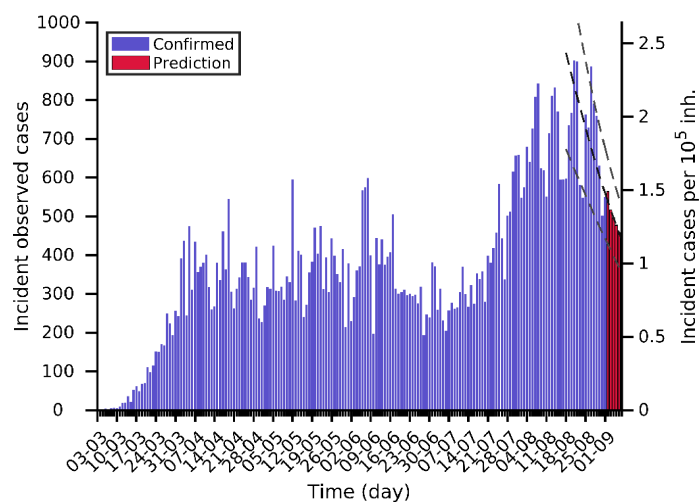
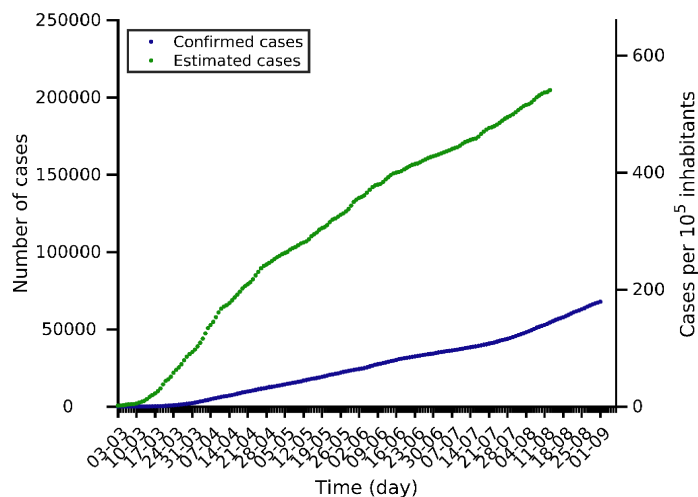
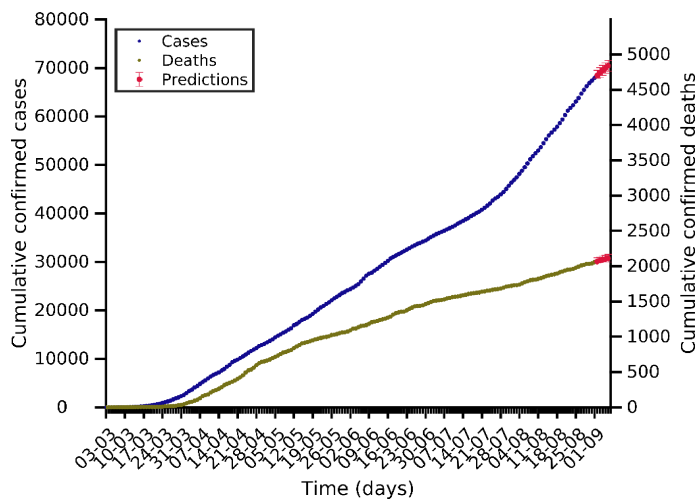
Sweden 01-09-2020. Pop: 10.1M. Cumulative incidence: 837/10⁵



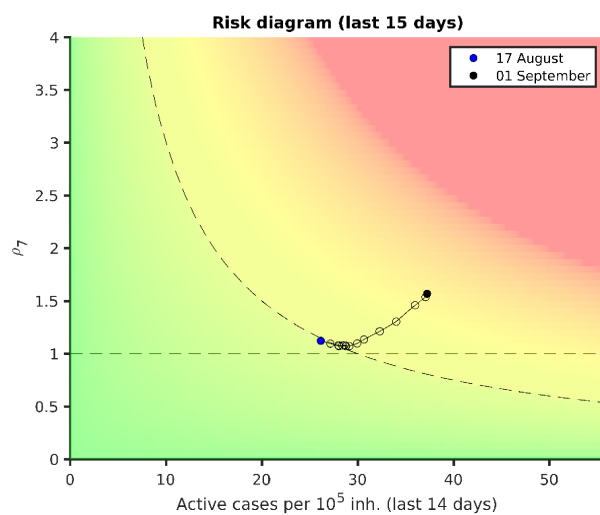
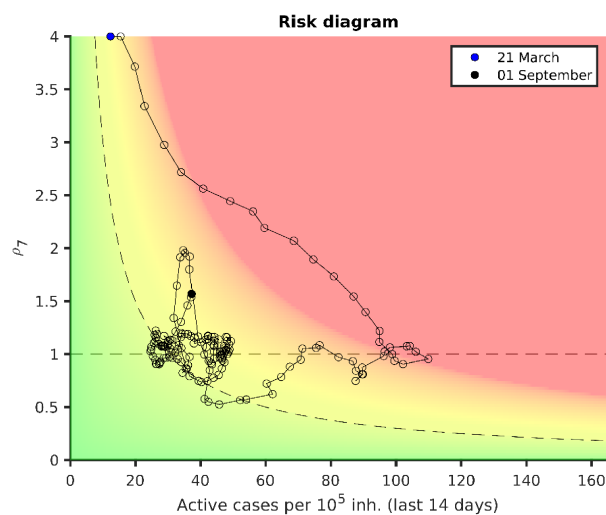
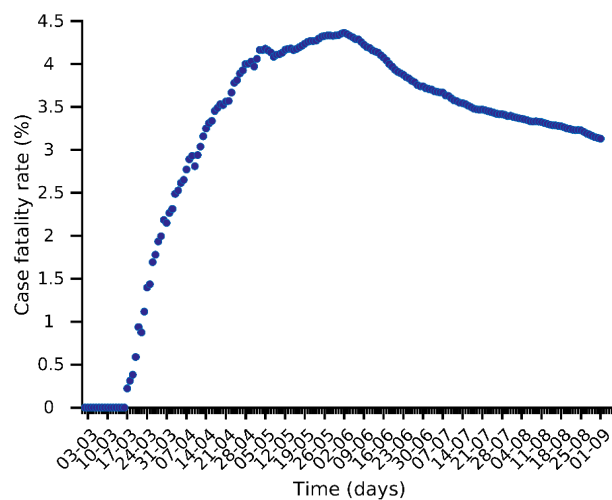
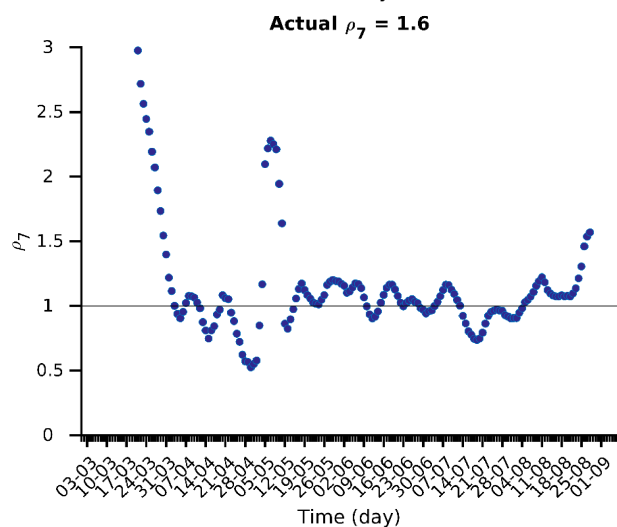
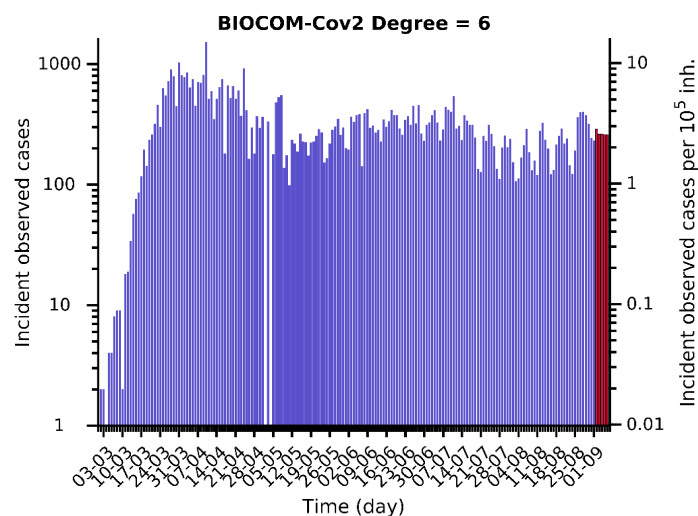
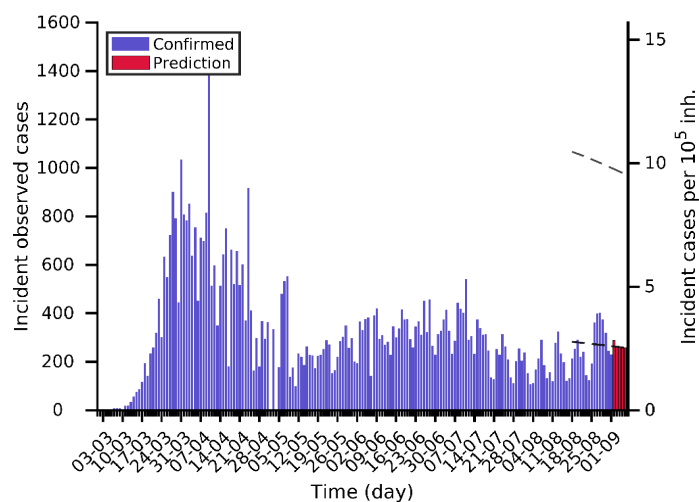
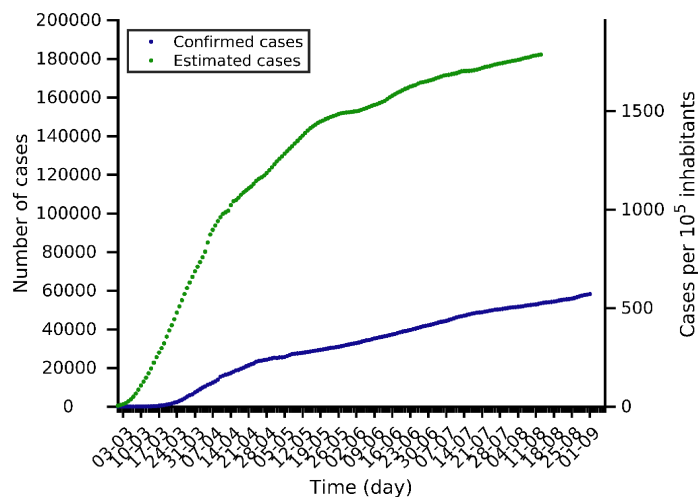
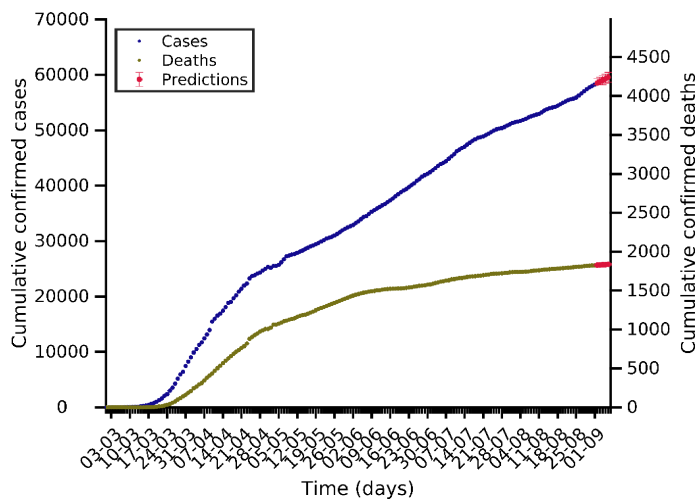
Netherlands 01-09-2020. Pop: 17.1M. Cumulative incidence: 415/10⁵



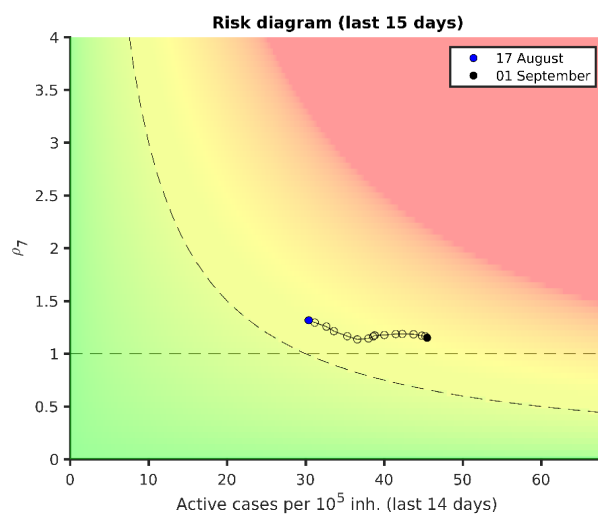
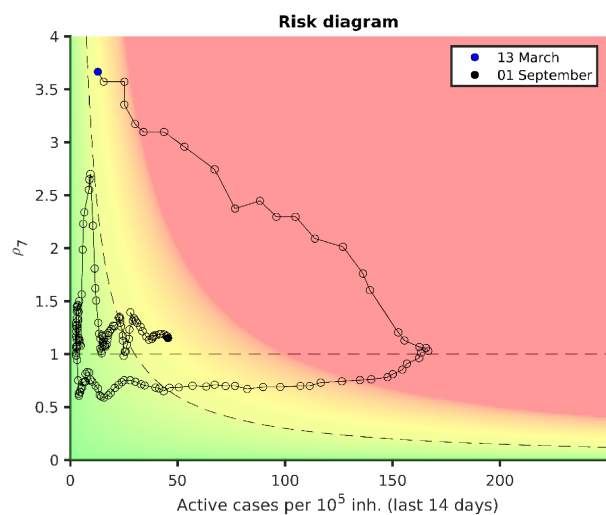
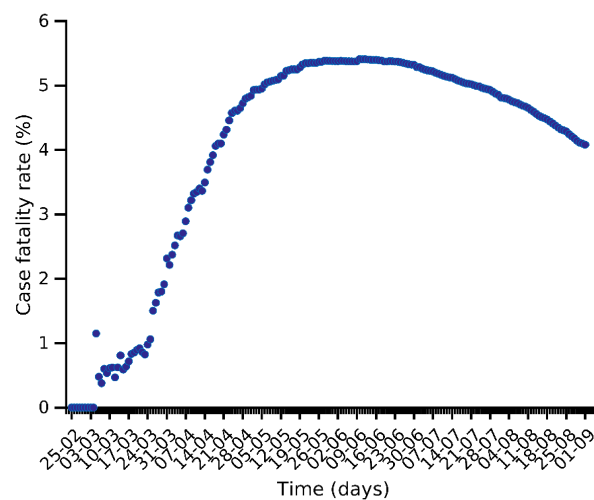
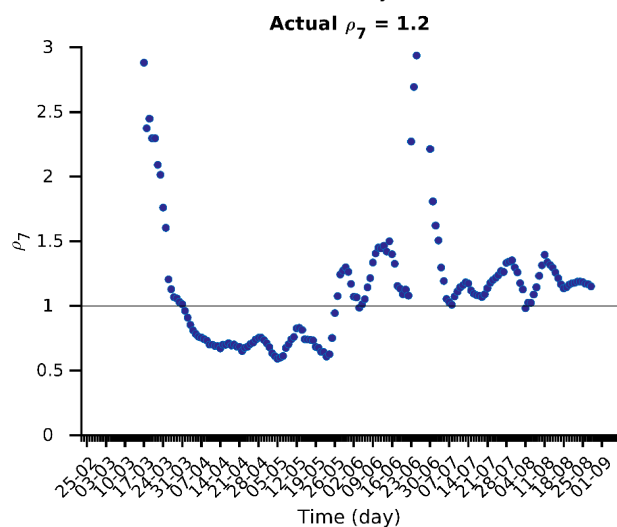
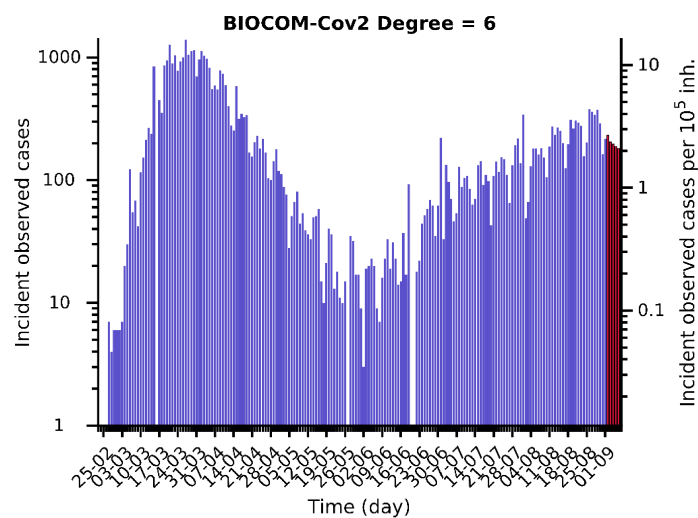
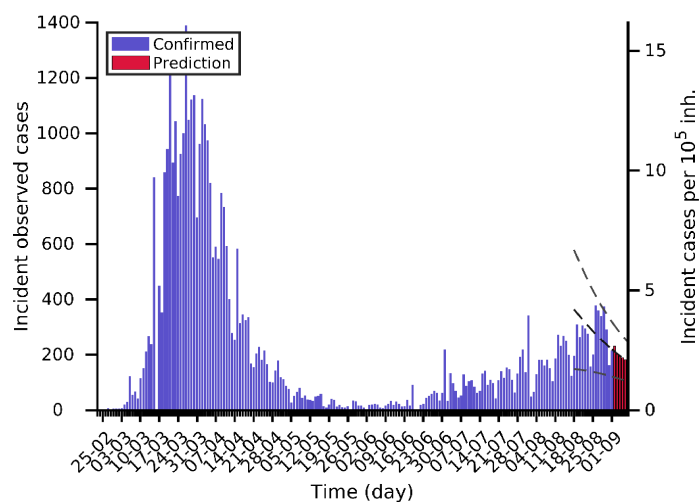
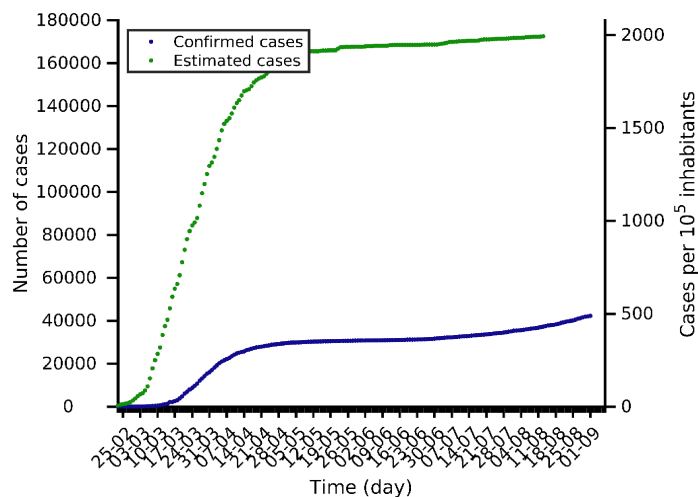
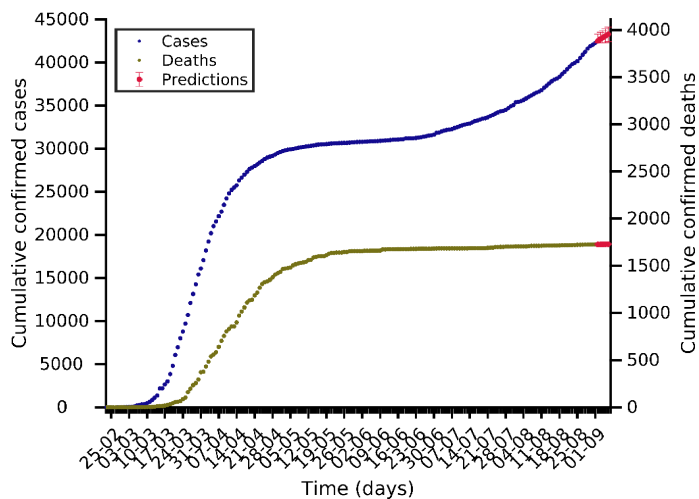
Poland 01-09-2020. Pop: 37.8M. Cumulative incidence: 179/10⁵



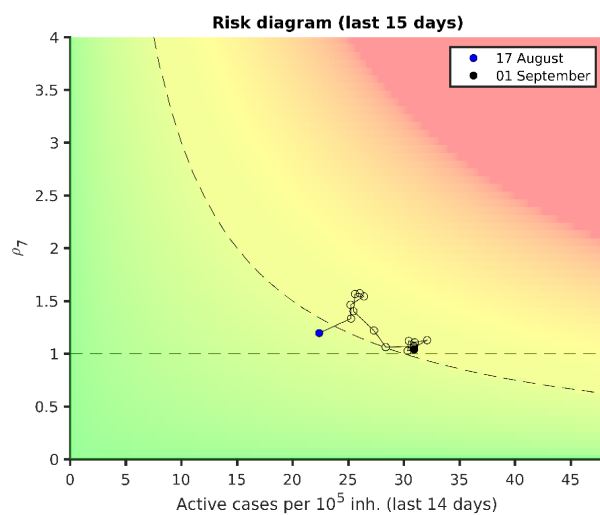
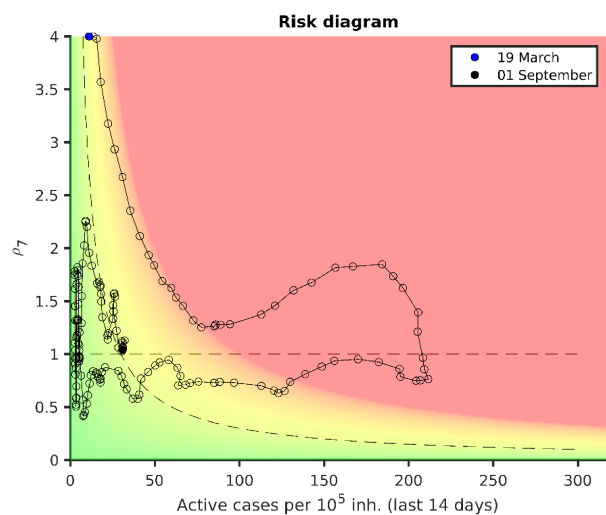
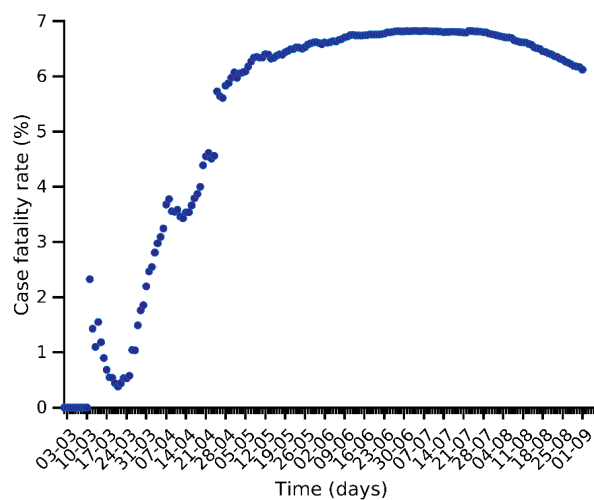
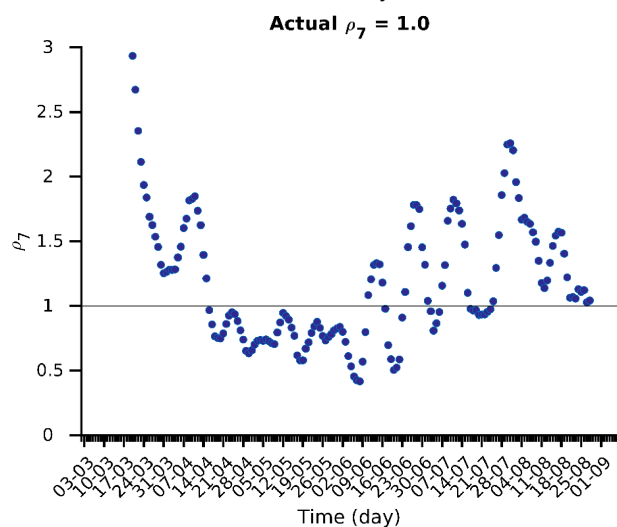
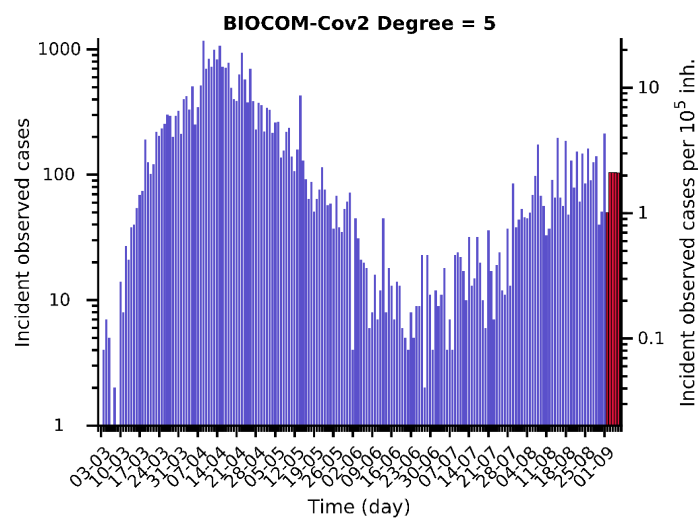
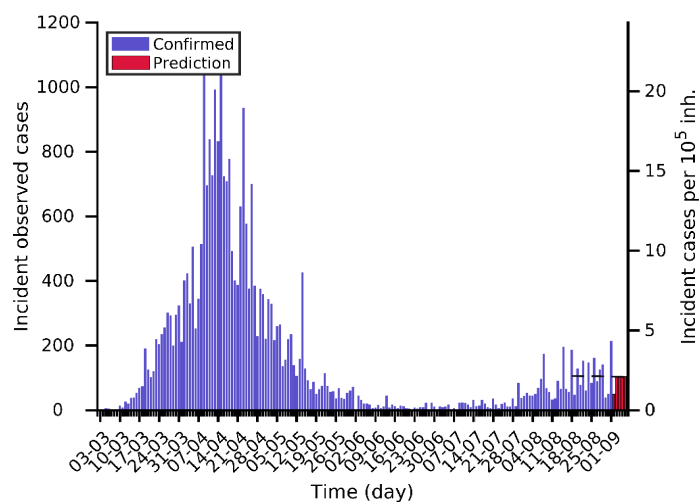
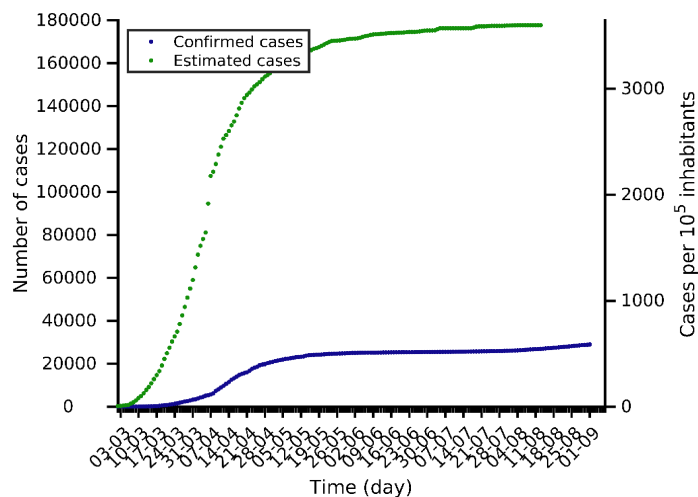
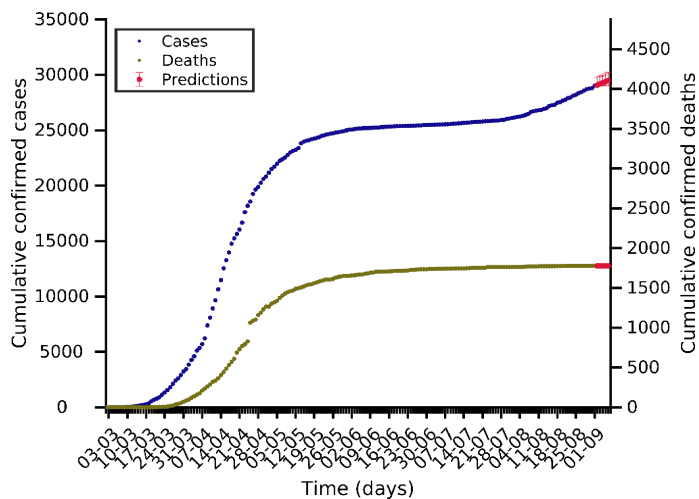
Portugal 01-09-2020. Pop: 10.2M. Cumulative incidence: 571/10⁵



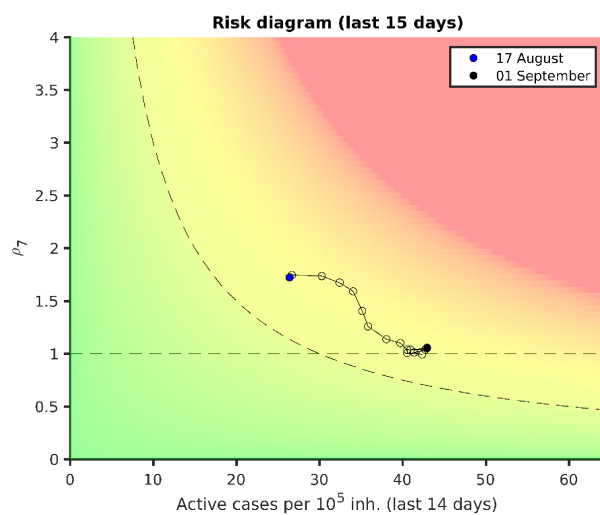
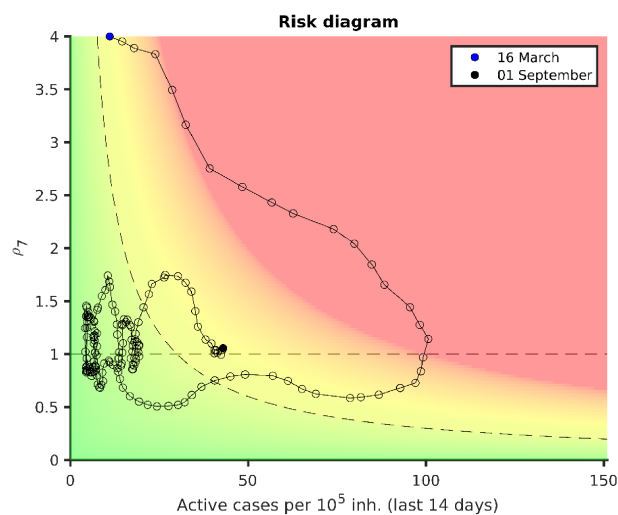
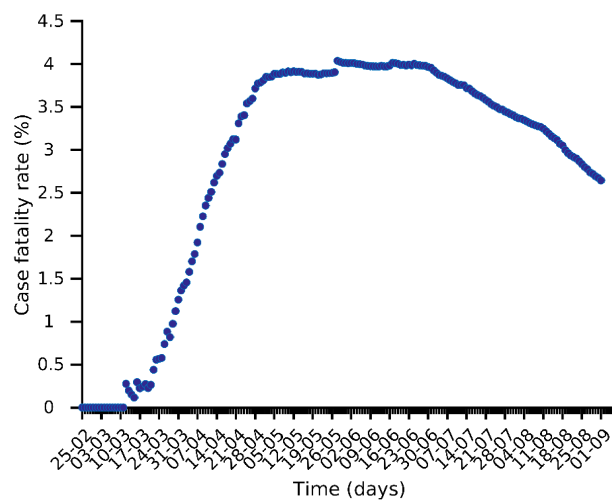
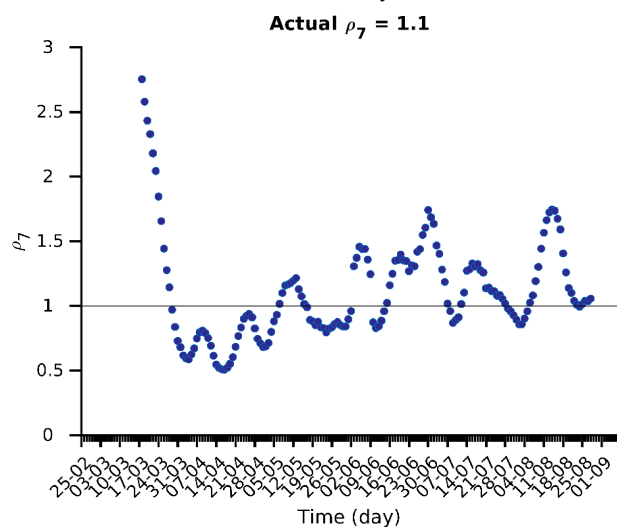
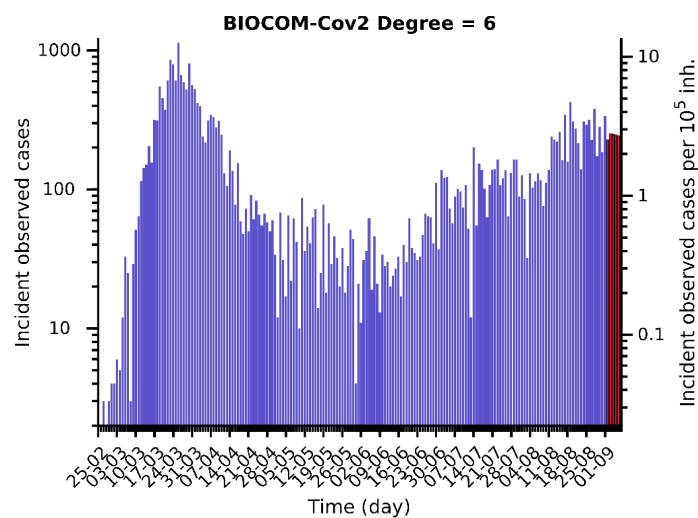
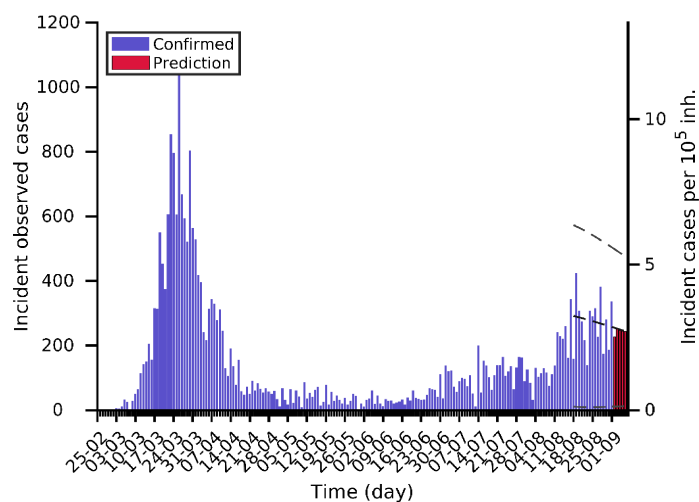
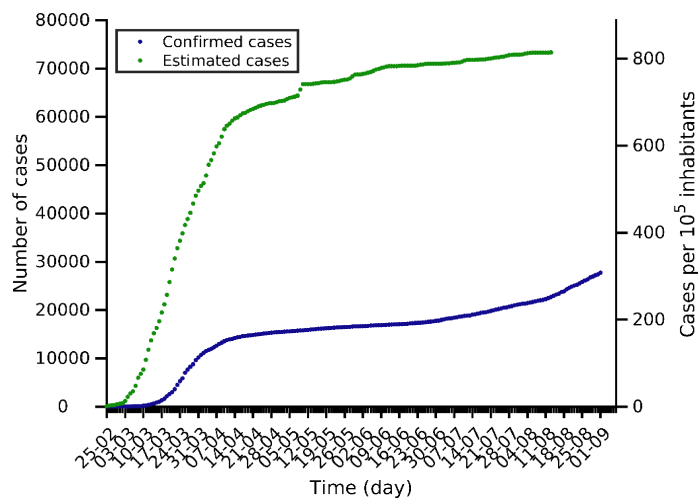
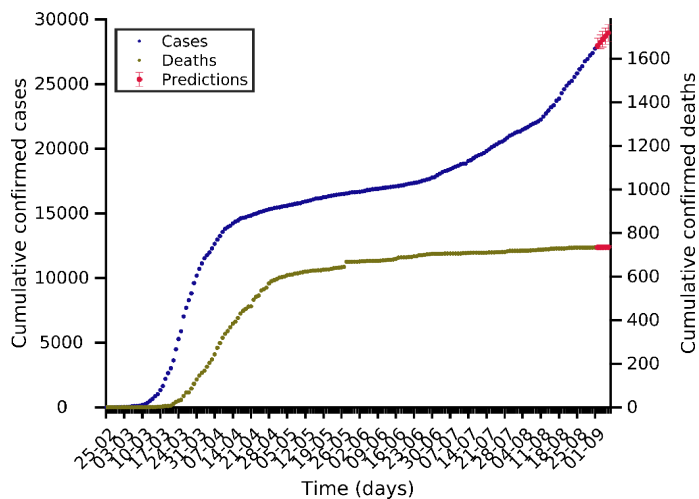
Switzerland 01-09-2020. Pop: 8.7M. Cumulative incidence: 489/10⁵



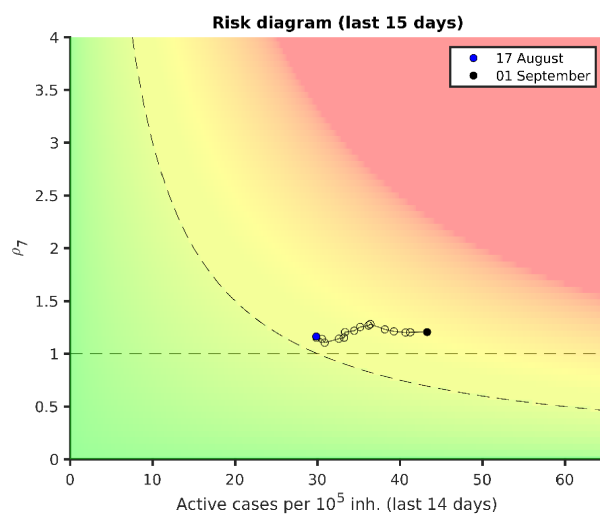
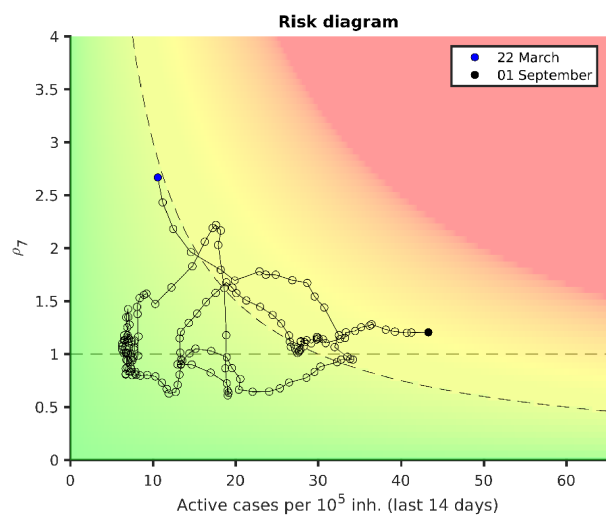
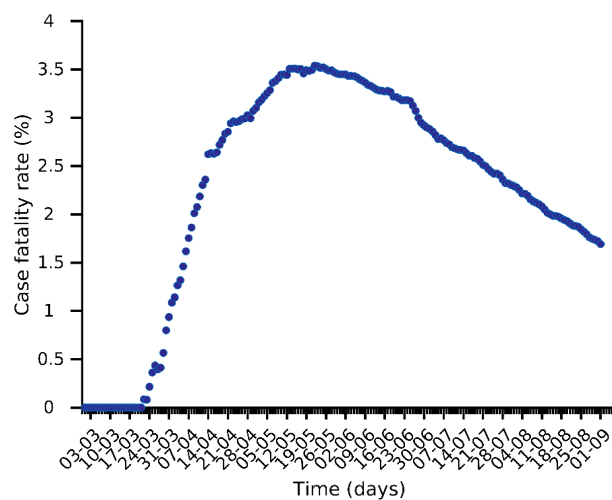
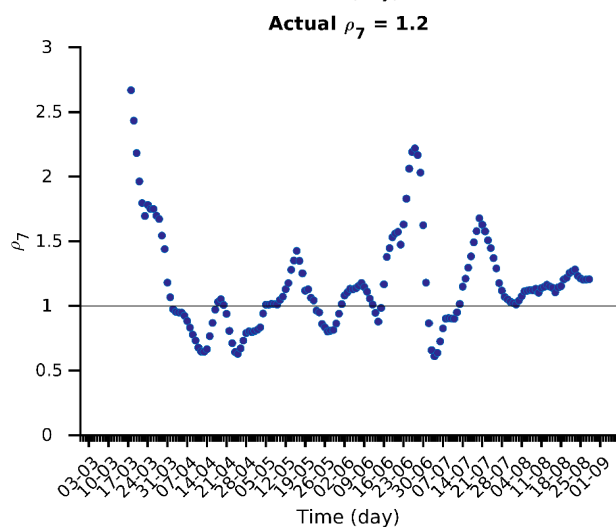
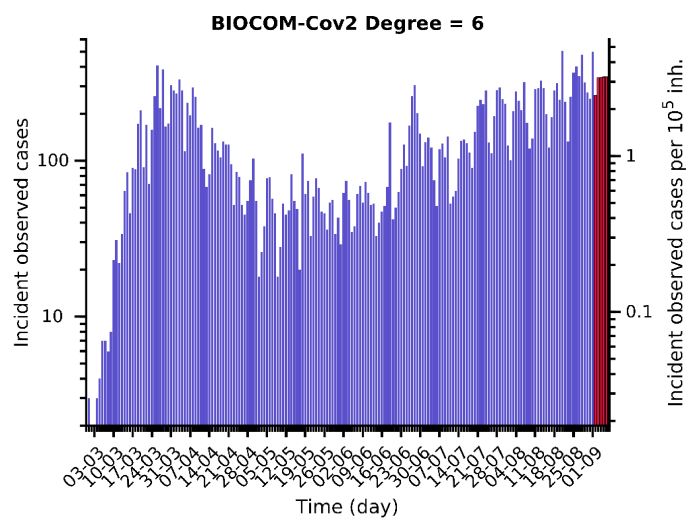
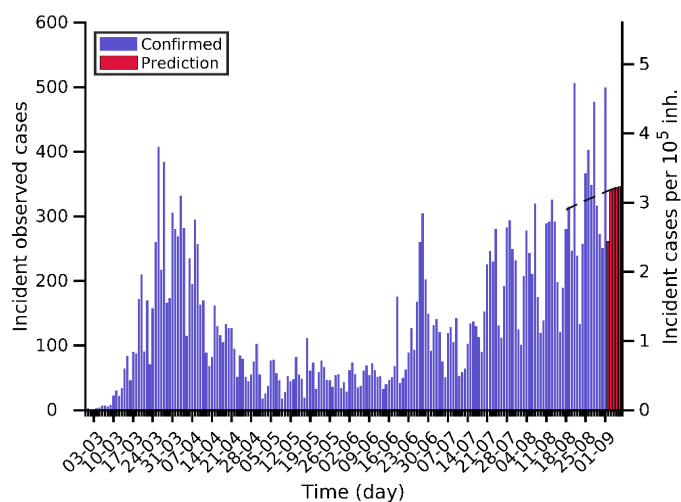
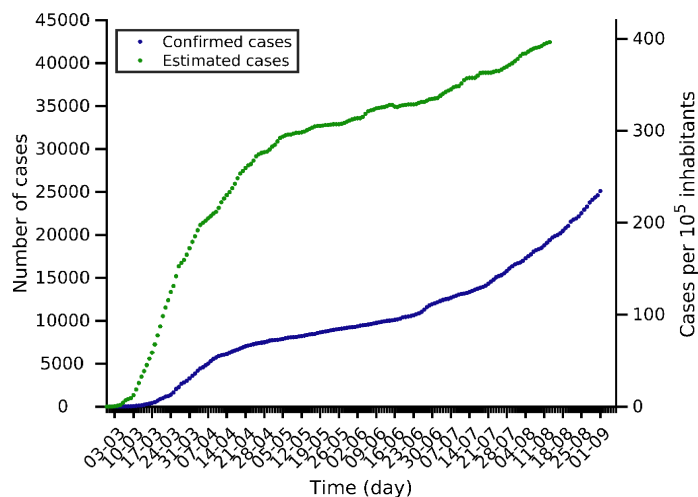
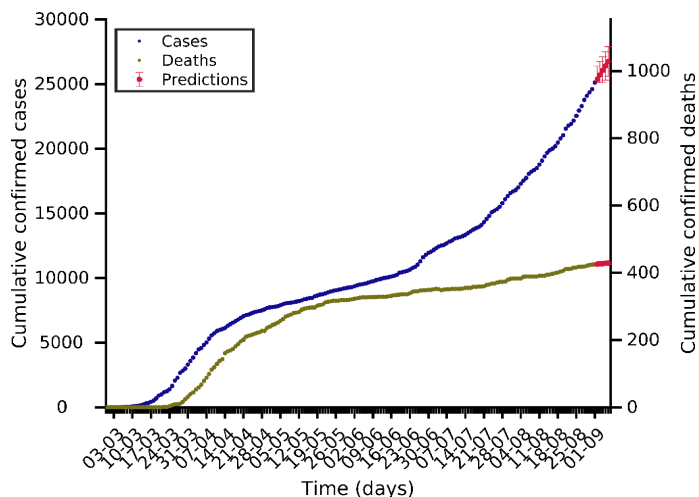
Ireland 01-09-2020. Pop: 4.9M. Cumulative incidence: 588/10⁵



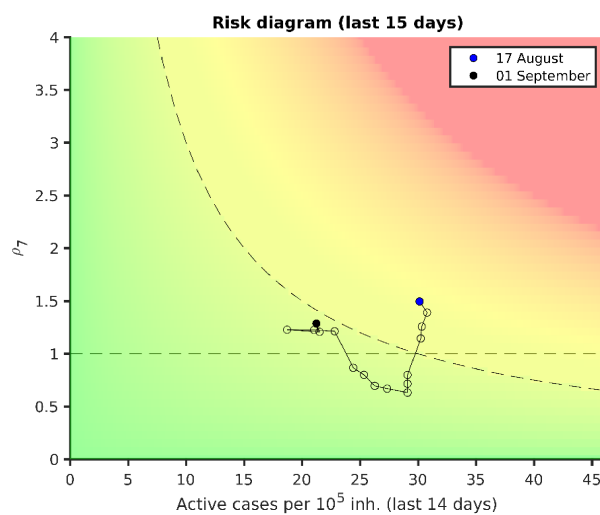
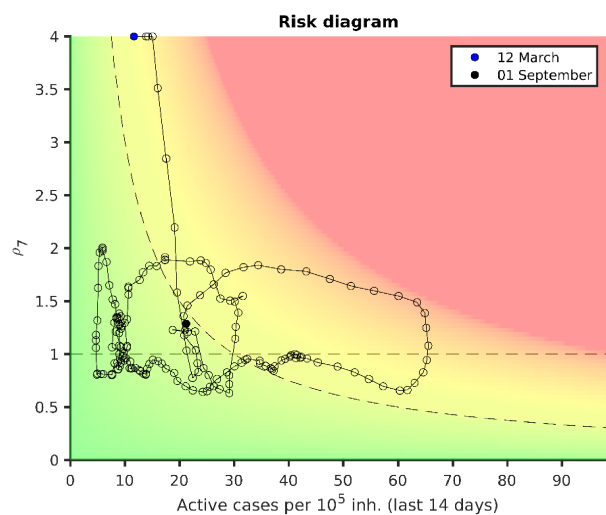
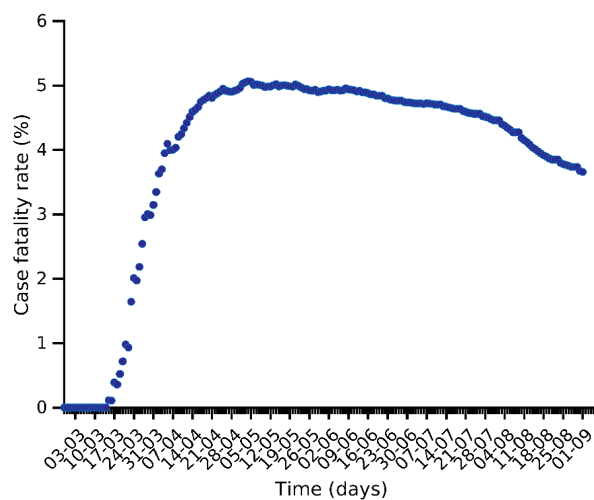
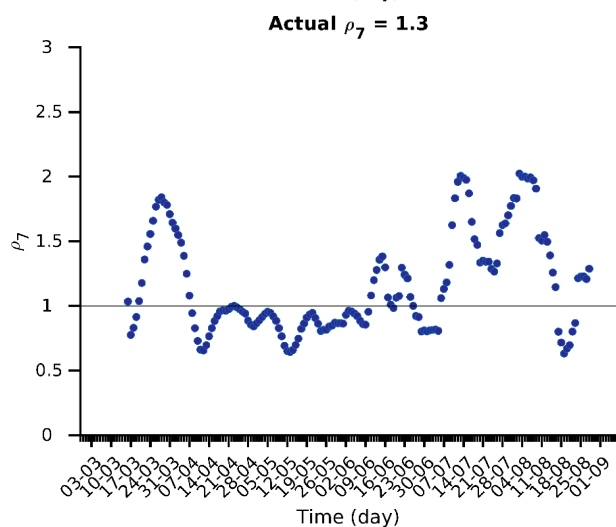
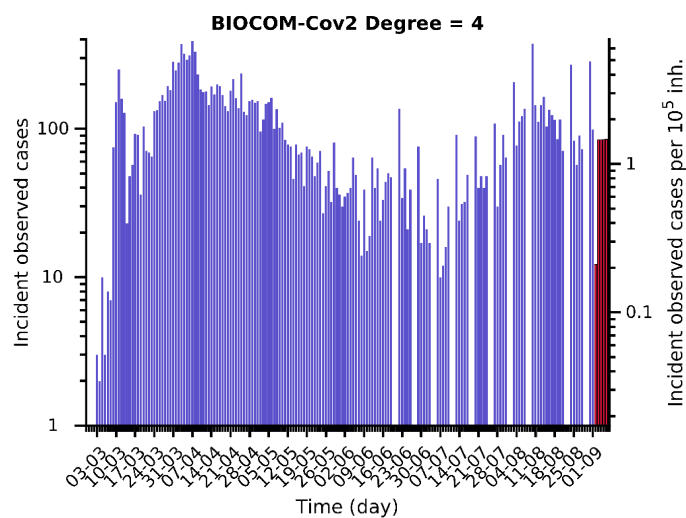
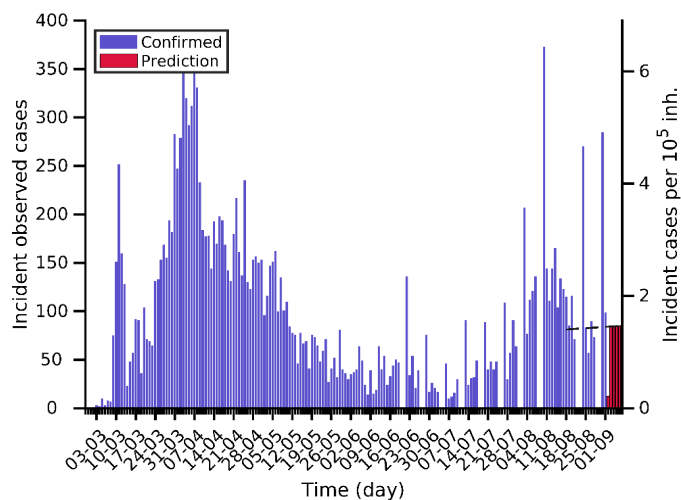
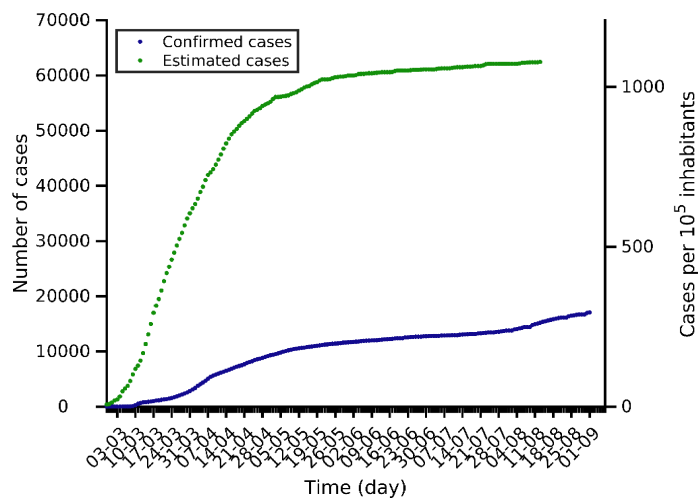
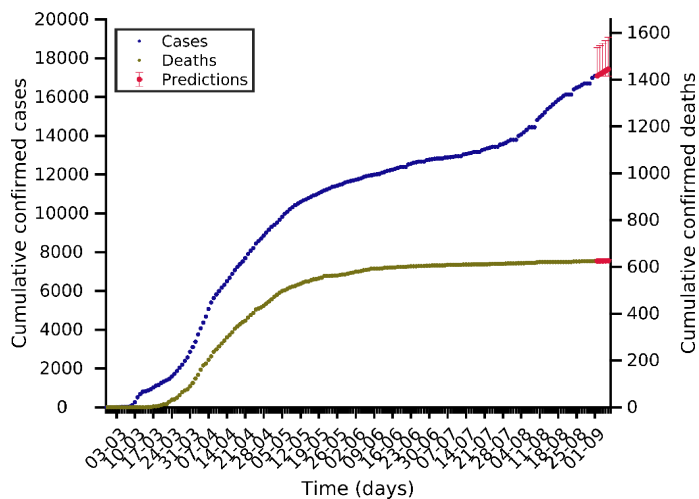
Austria 01-09-2020. Pop: 9.0M. Cumulative incidence: 308/10⁵



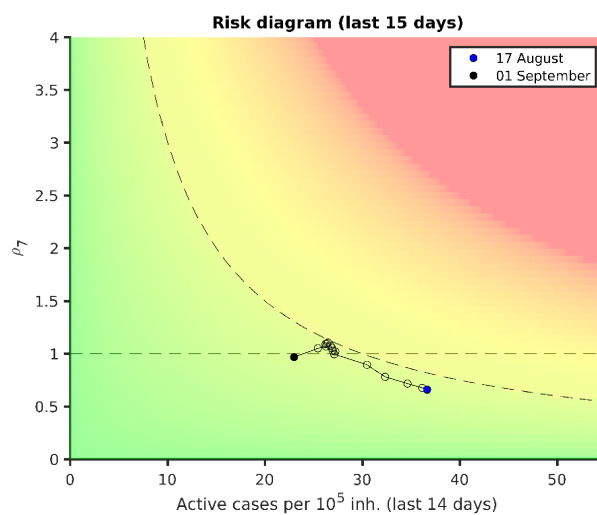
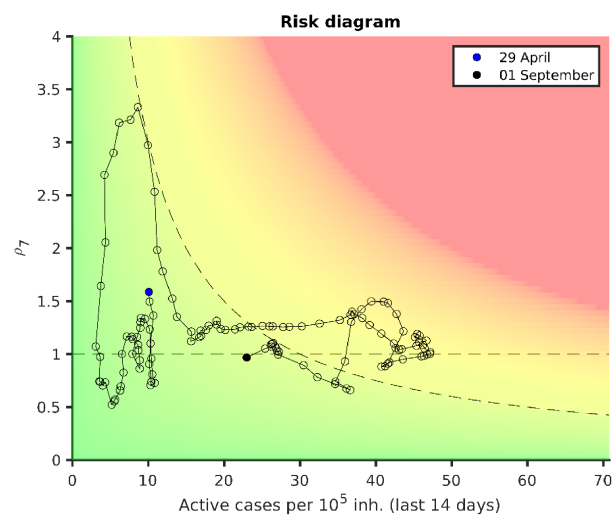
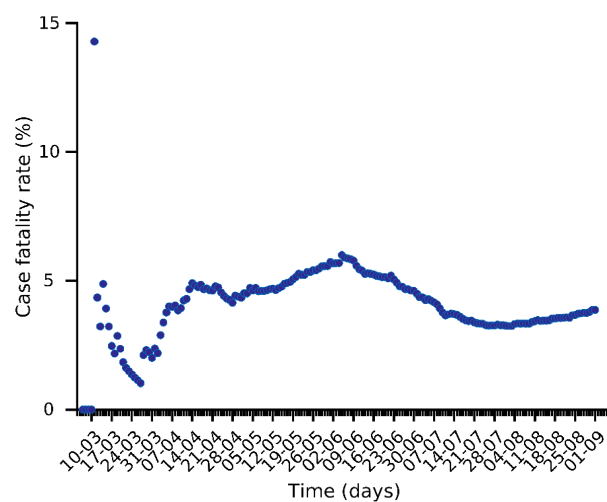
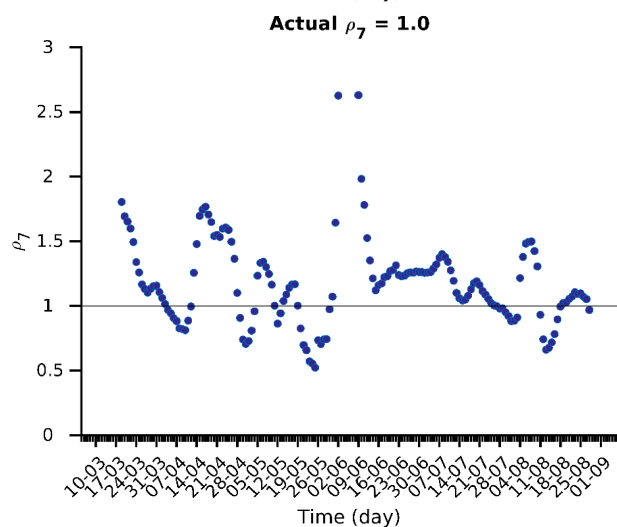
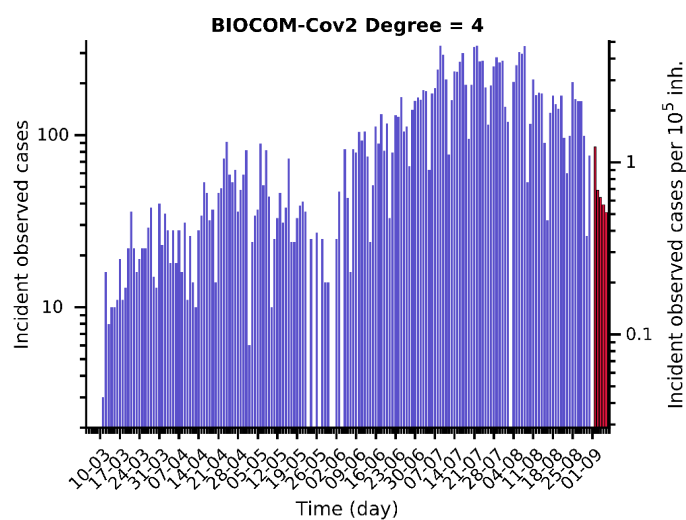
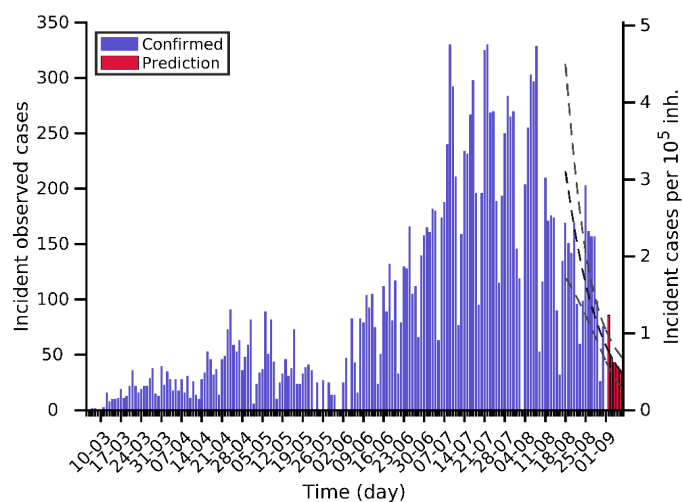
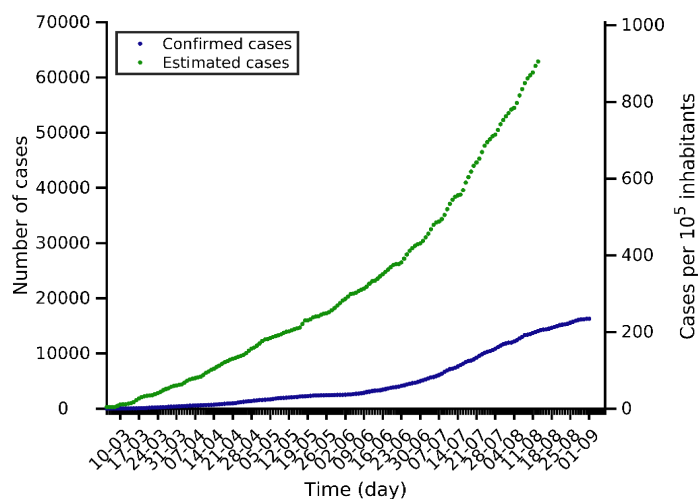
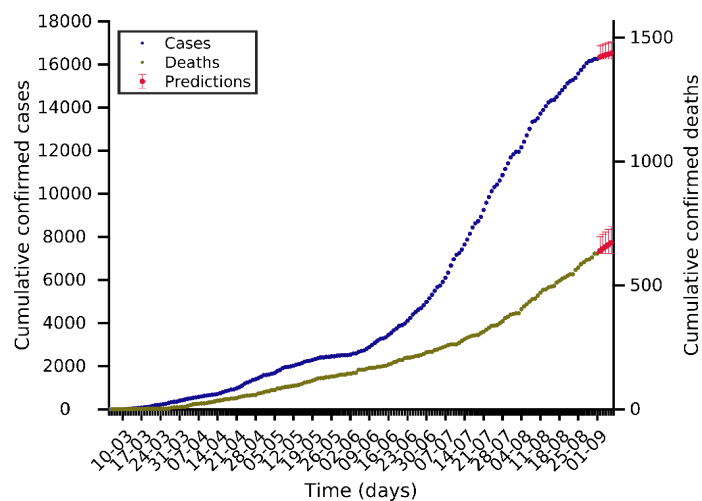
Czech Rep 01-09-2020. Pop: 10.7M. Cumulative incidence: 235/10⁵



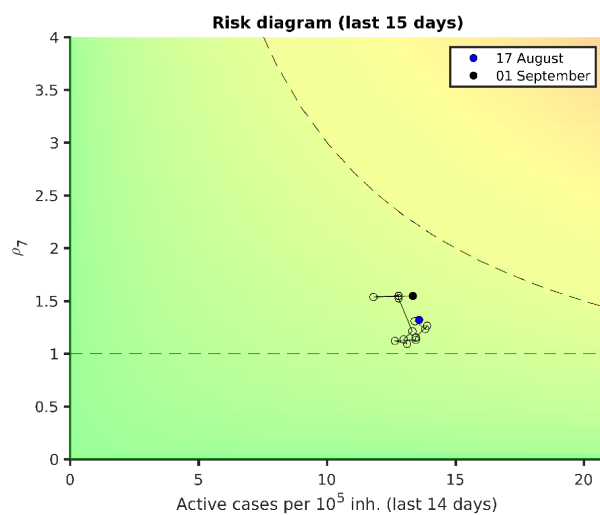
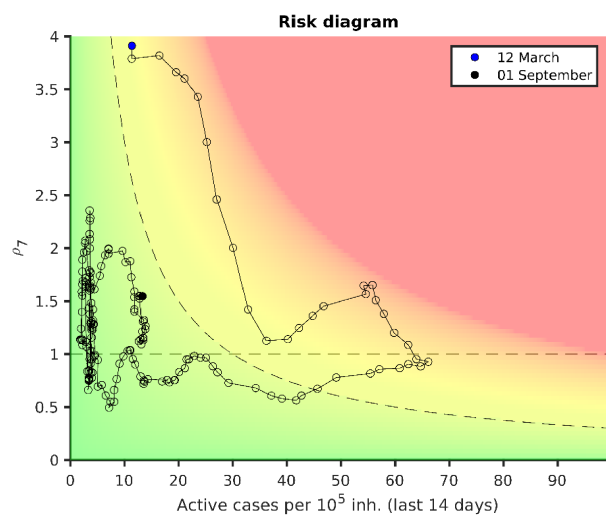
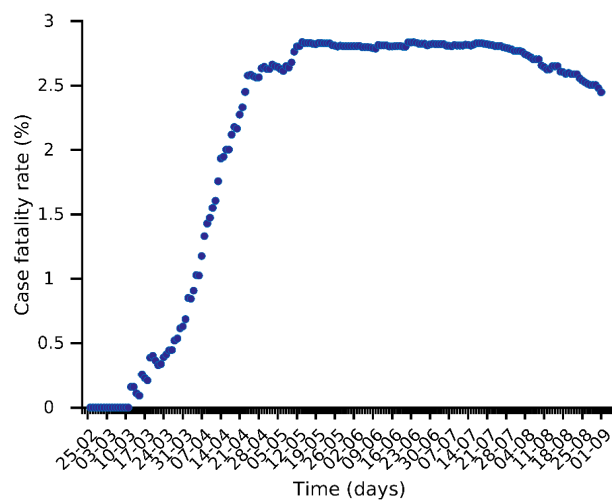
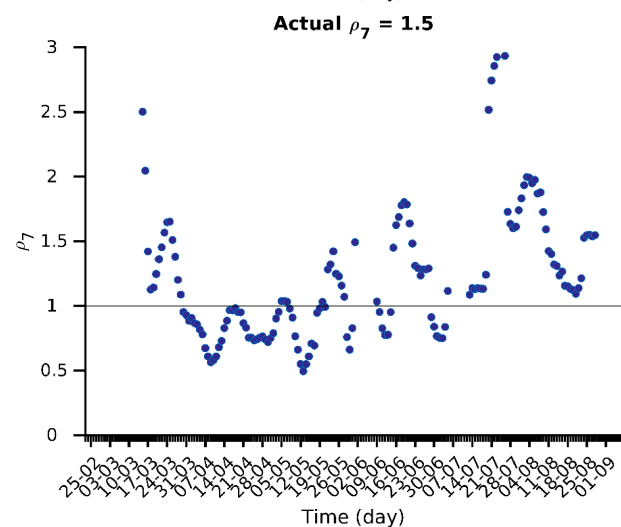
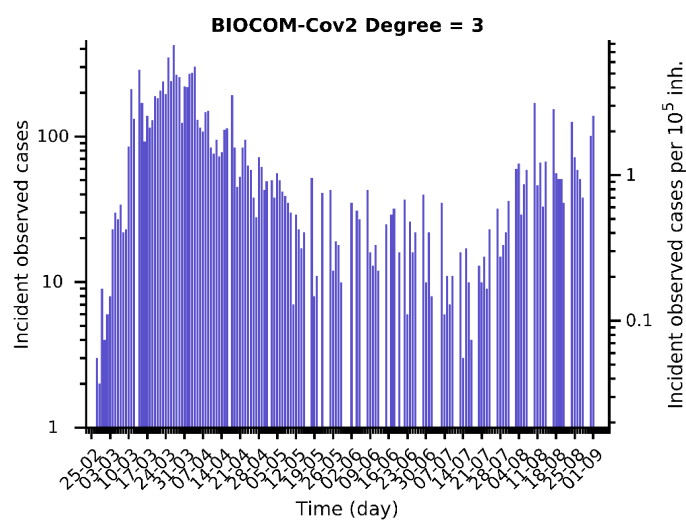
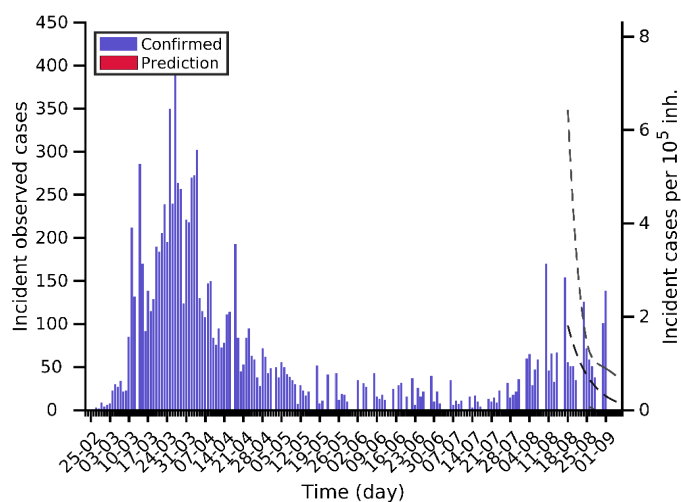
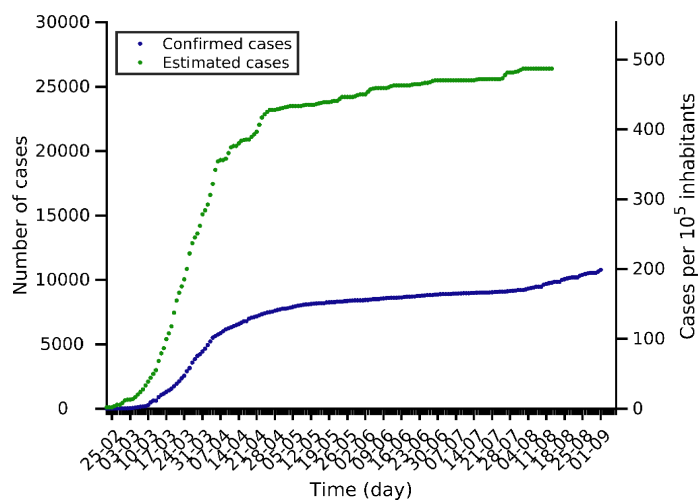
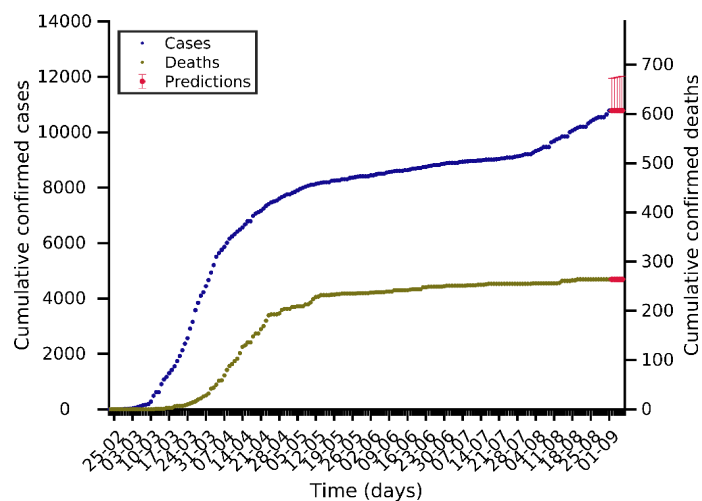
Denmark 01-09-2020. Pop: 5.8M. Cumulative incidence: 295/10⁵



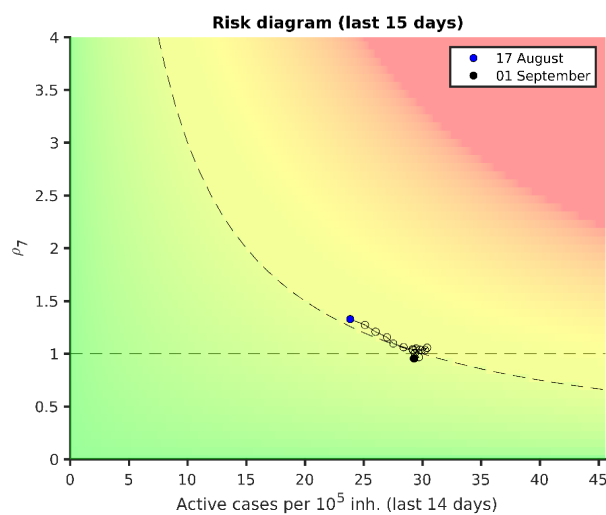
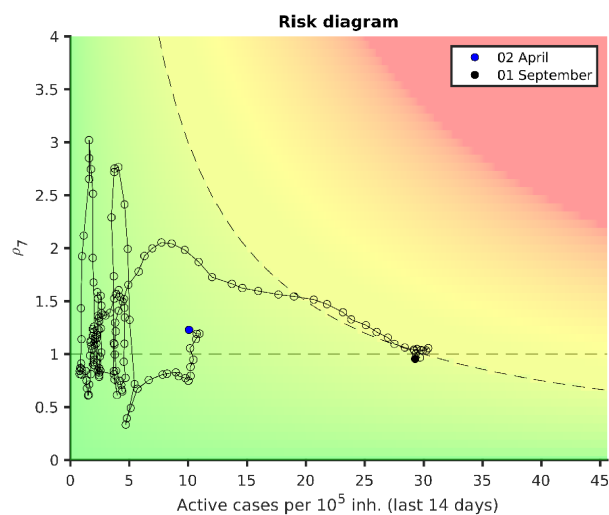
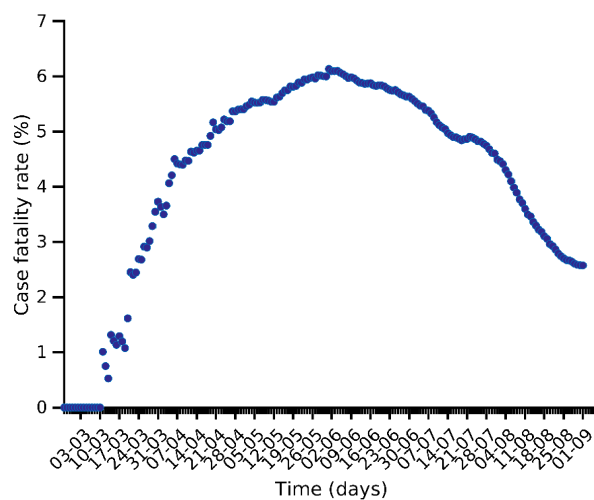
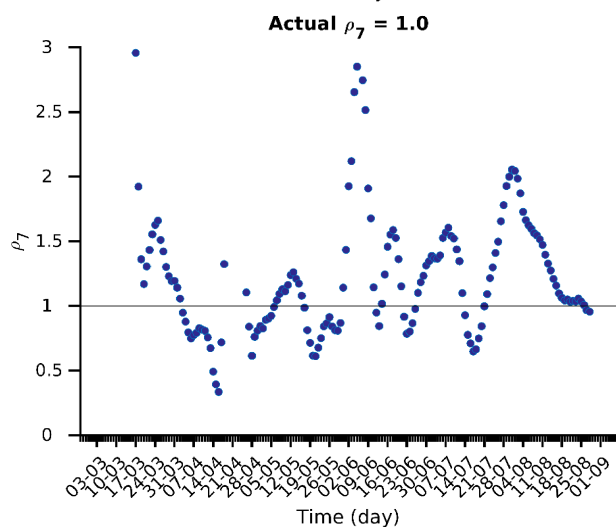
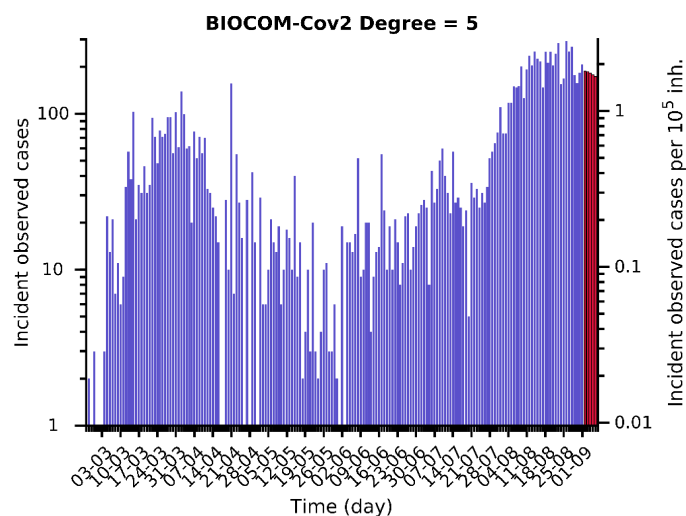
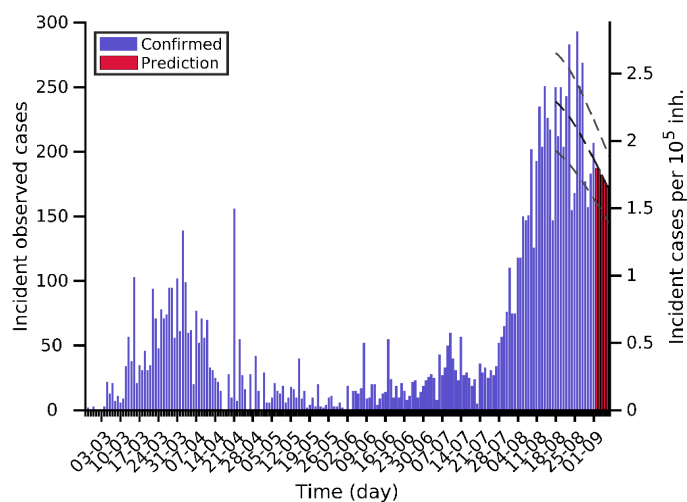
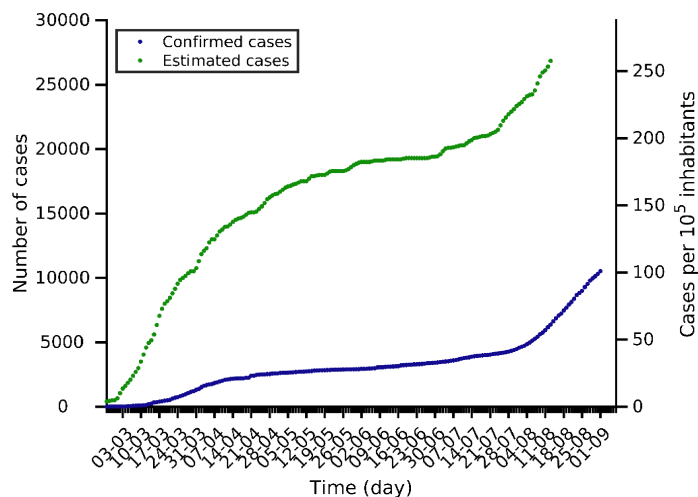
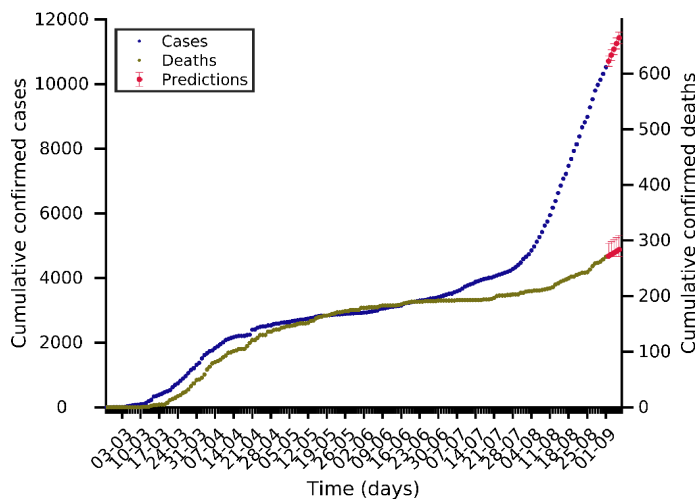
Bulgaria 01-09-2020. Pop: 6.9M. Cumulative incidence: 234/10⁵



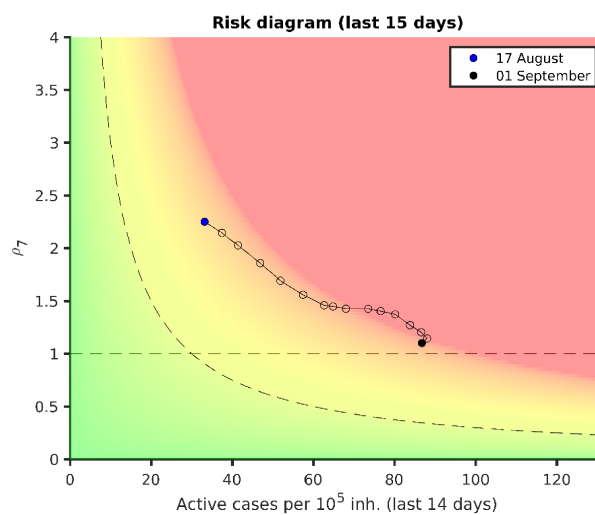
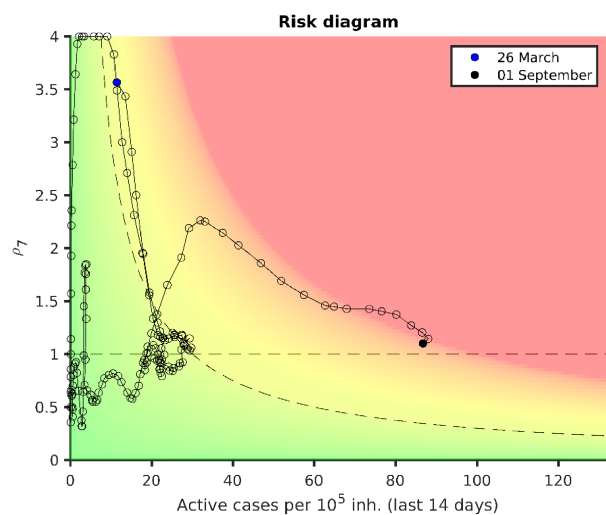
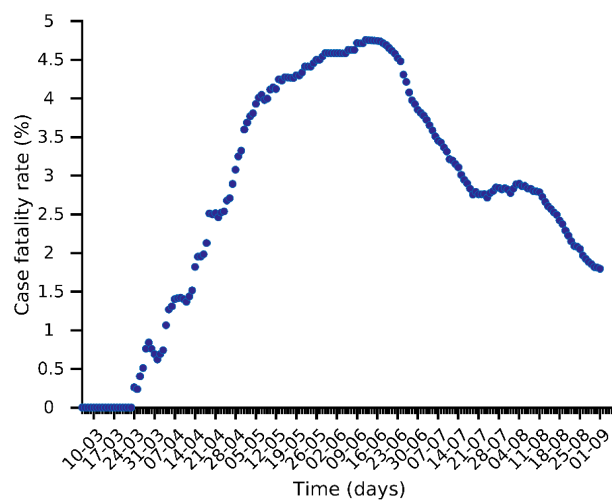
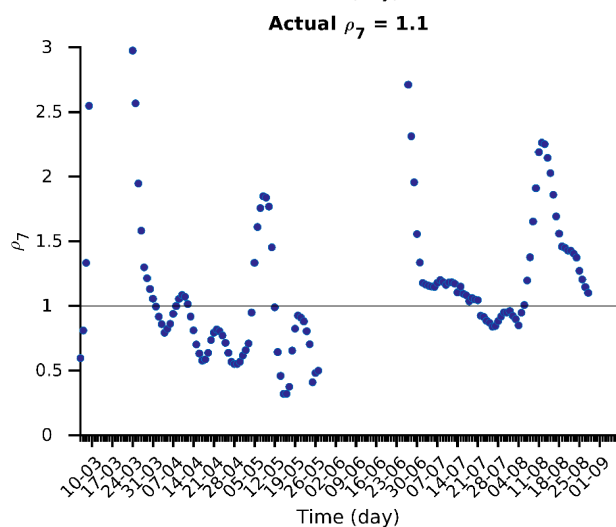
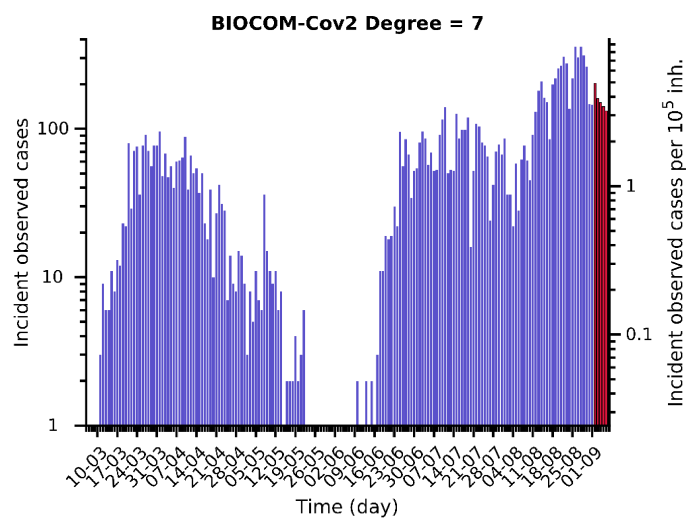
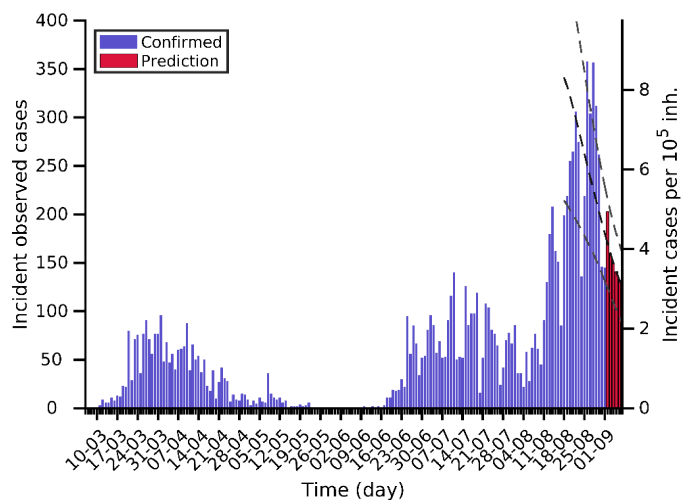
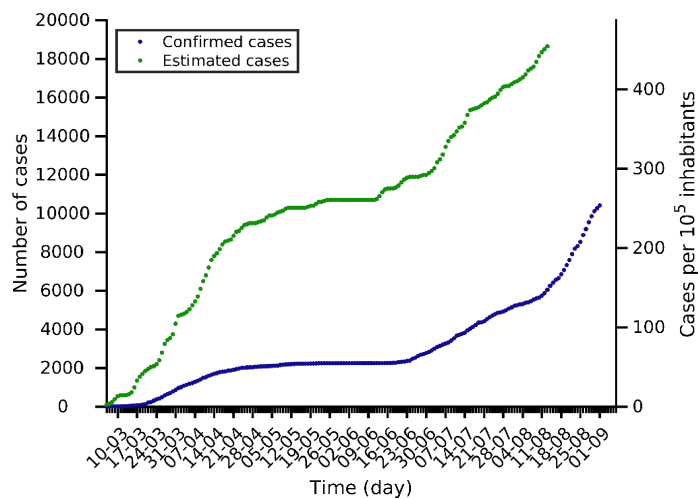
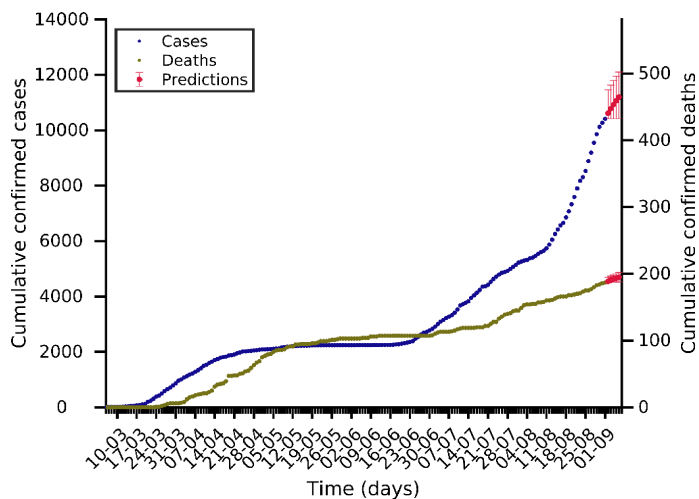
Norway 01-09-2020. Pop: 5.4M. Cumulative incidence: 199/10⁵



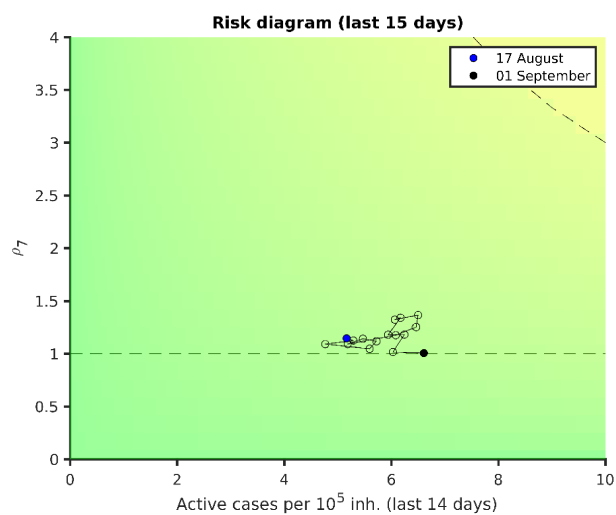
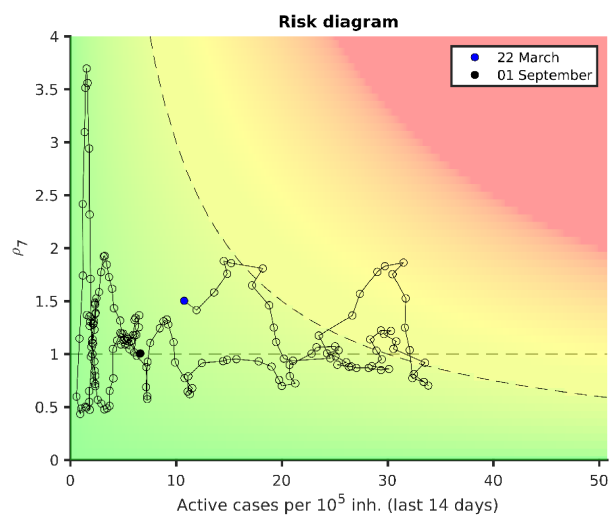
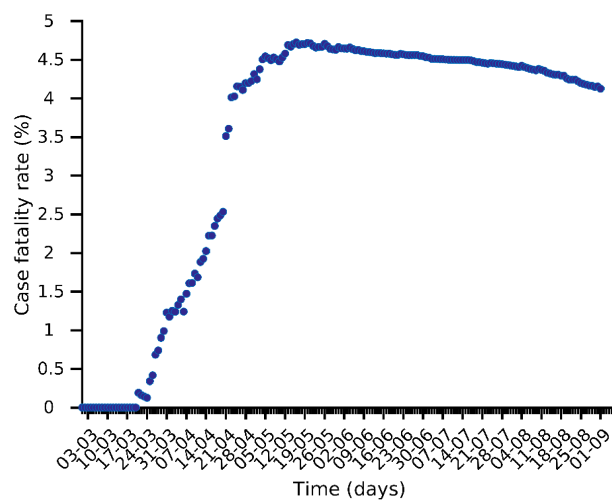
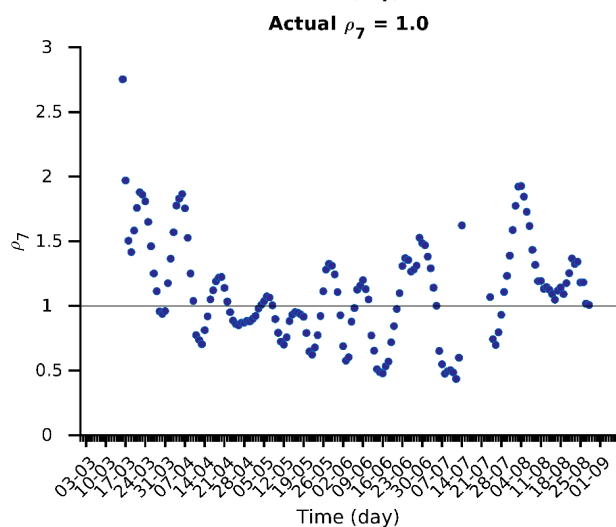
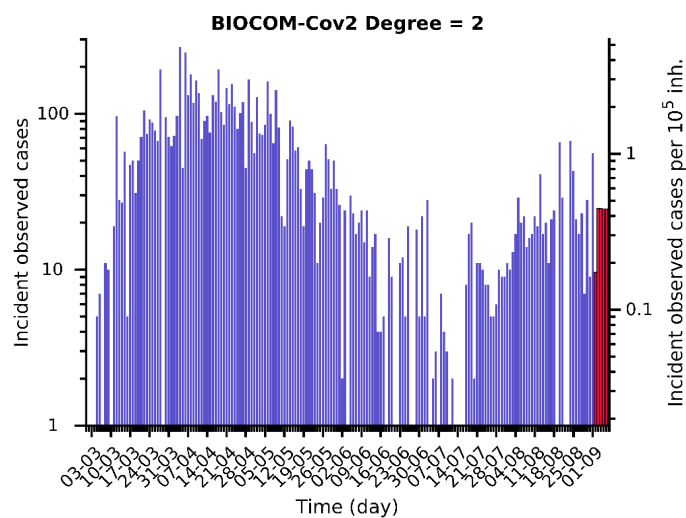
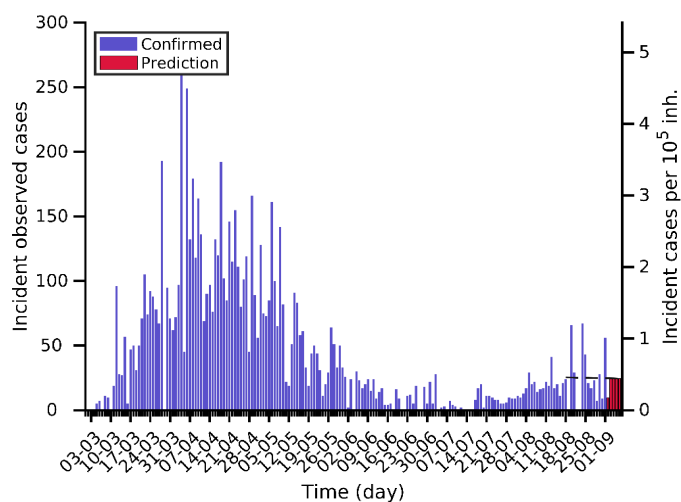
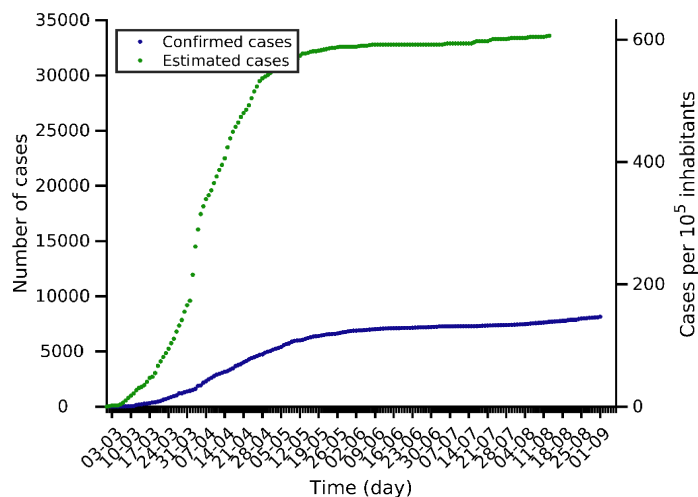
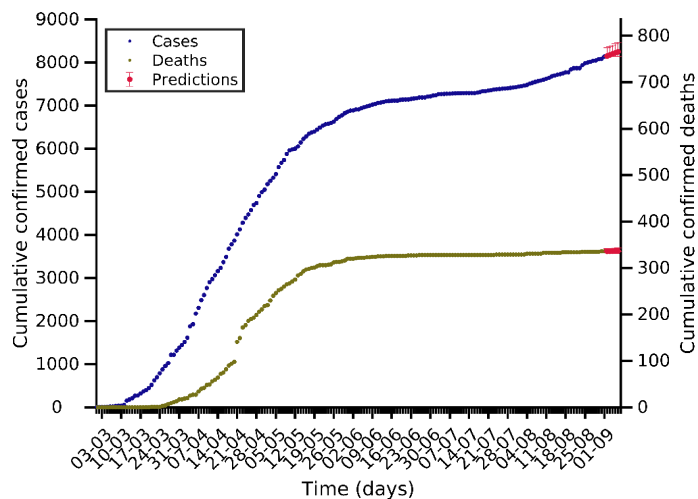
Greece 01-09-2020. Pop: 10.4M. Cumulative incidence: 101/10⁵



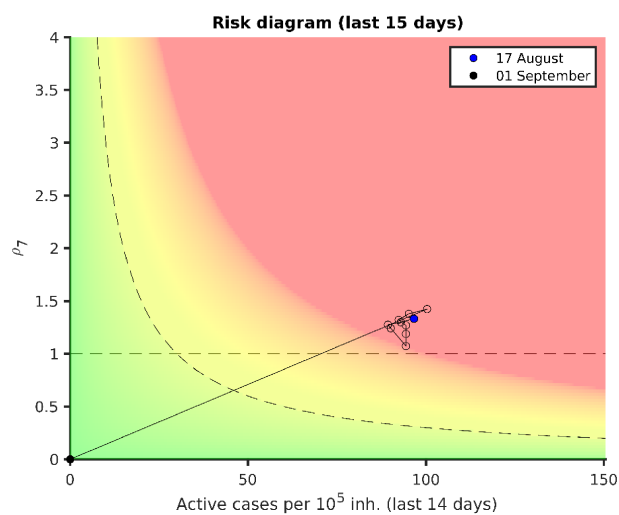
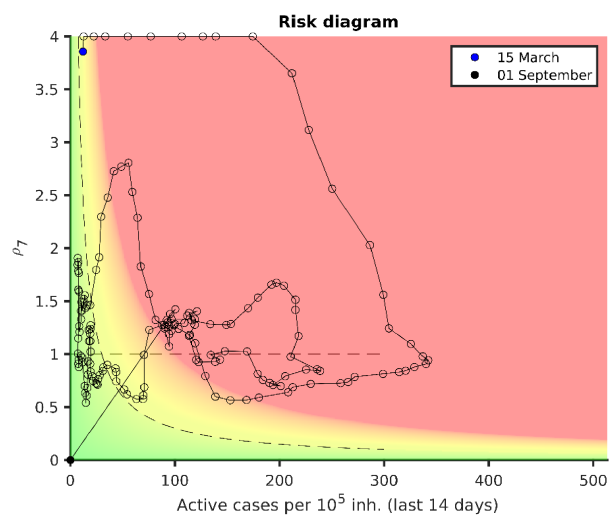
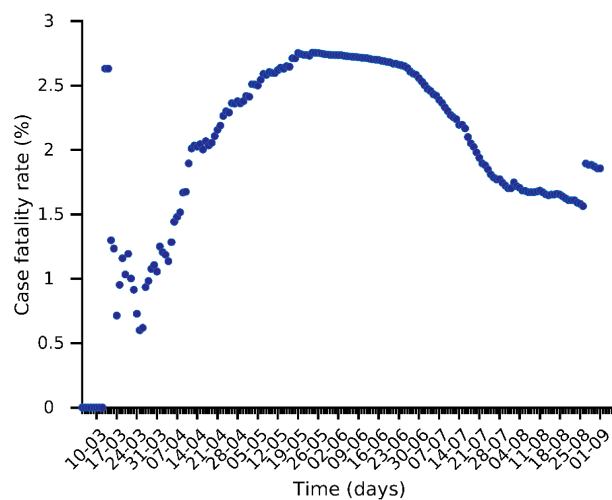
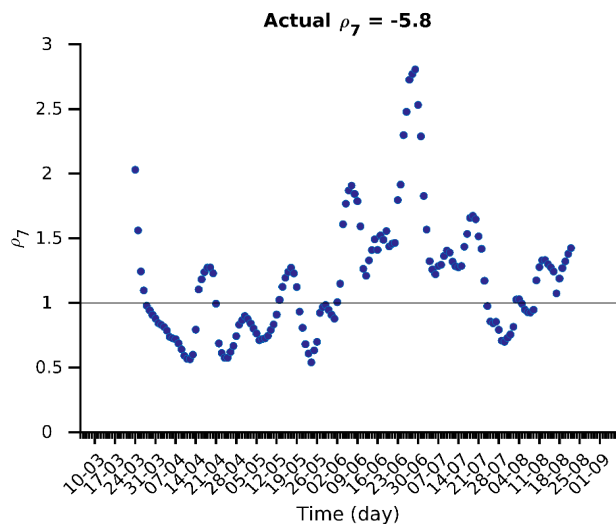
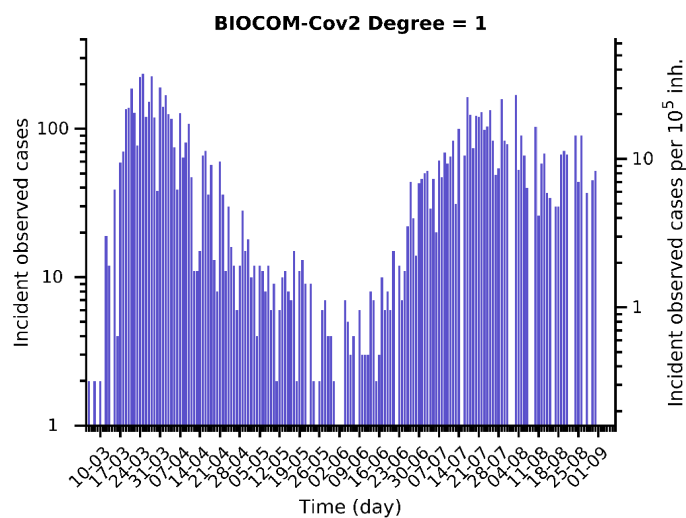
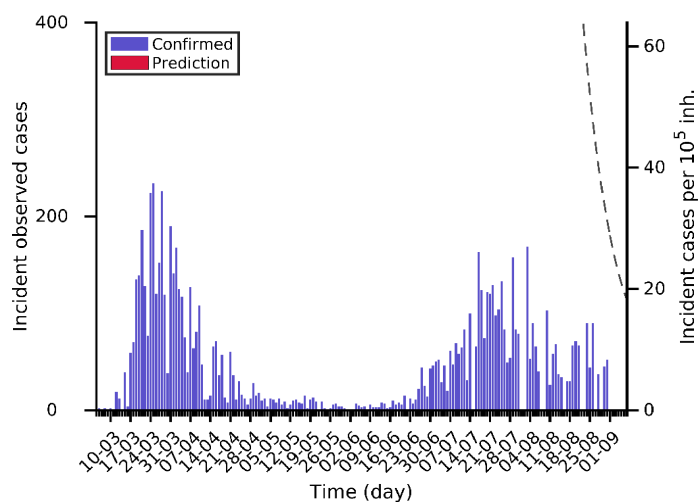
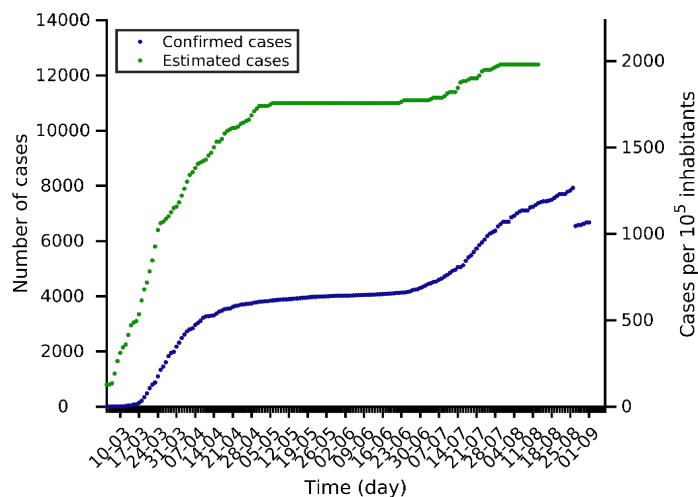
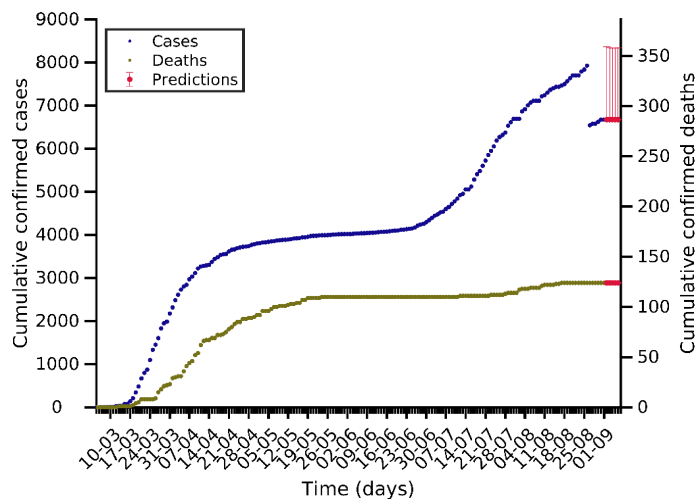
Croatia 01-09-2020. Pop: 4.1M. Cumulative incidence: 254/10⁵



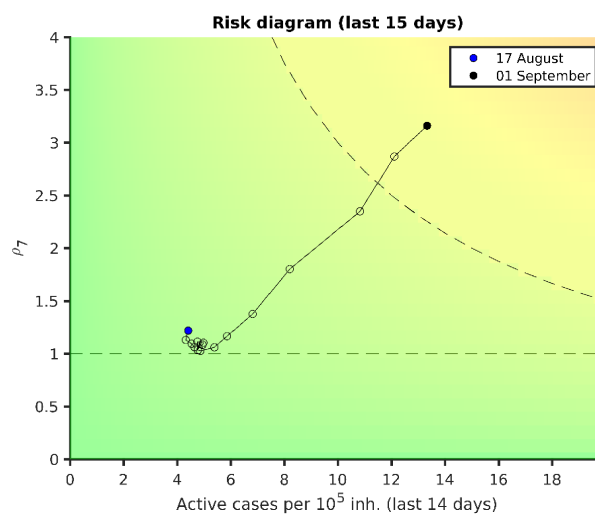
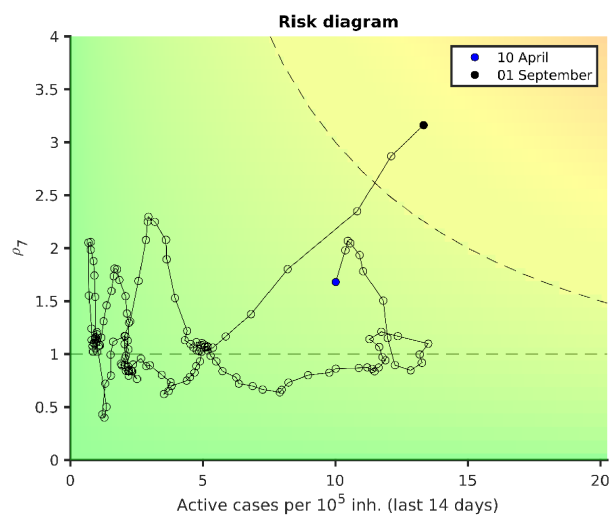
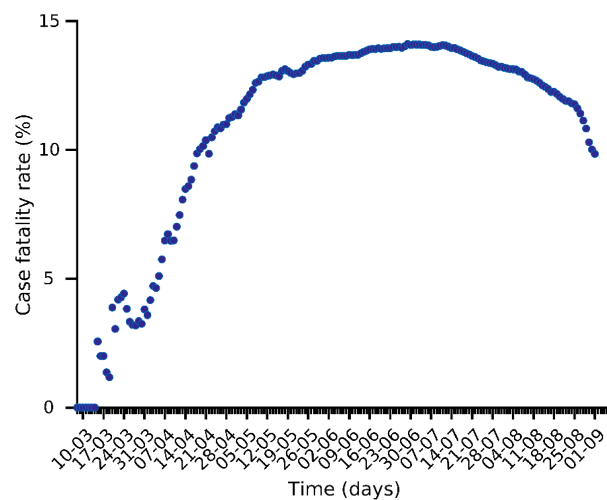
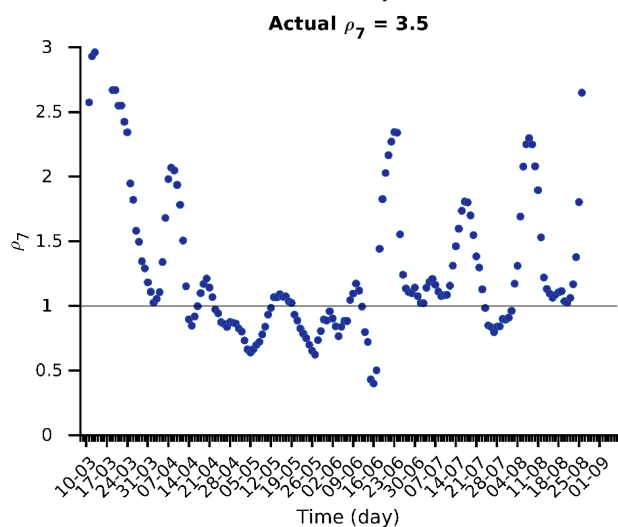
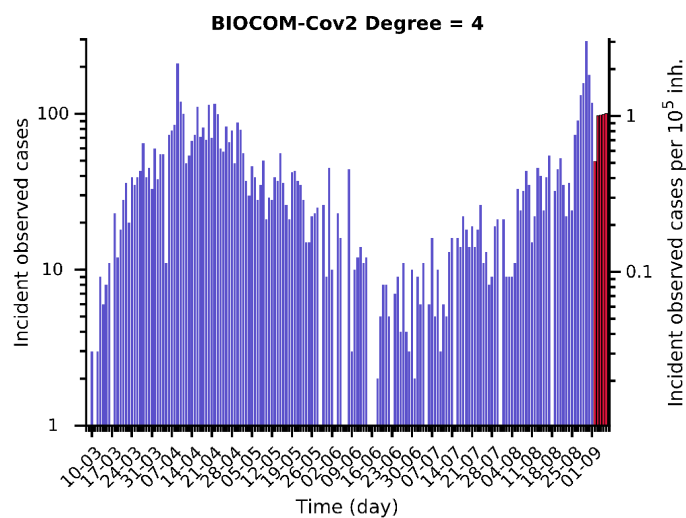
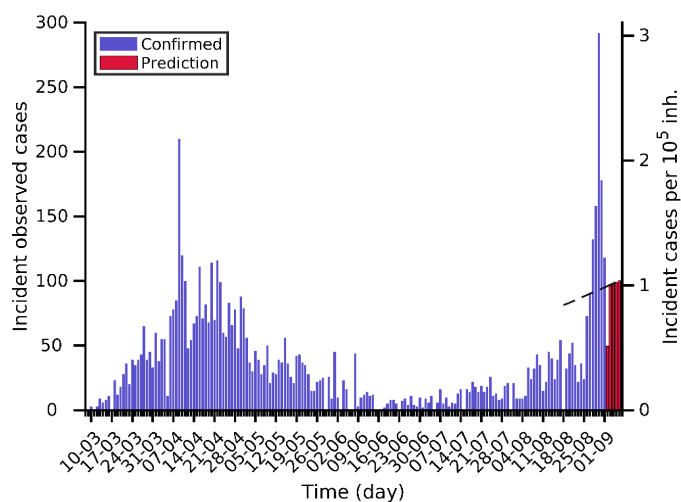
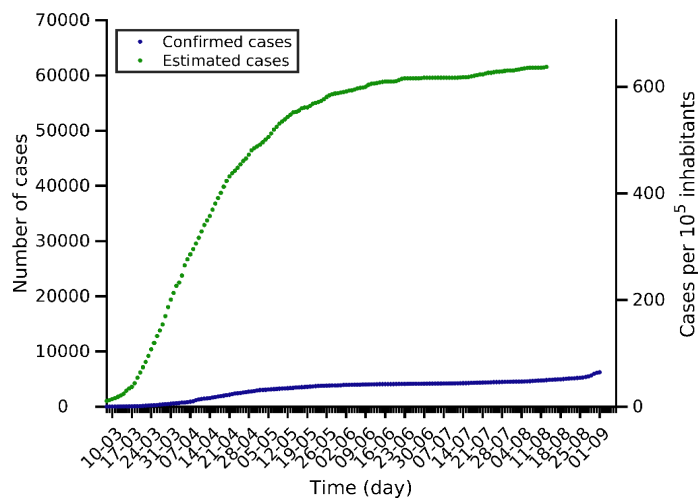
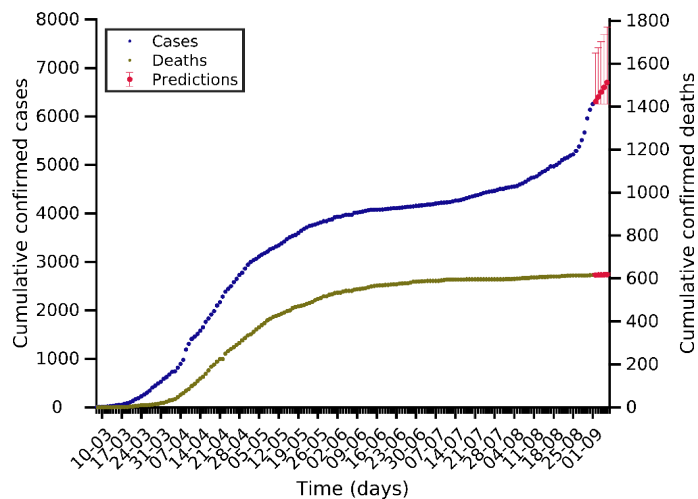
Finland 01-09-2020. Pop: 5.5M. Cumulative incidence: 147/10⁵



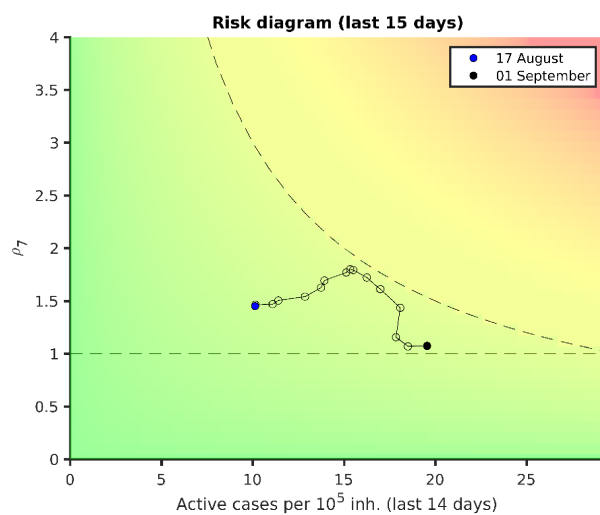
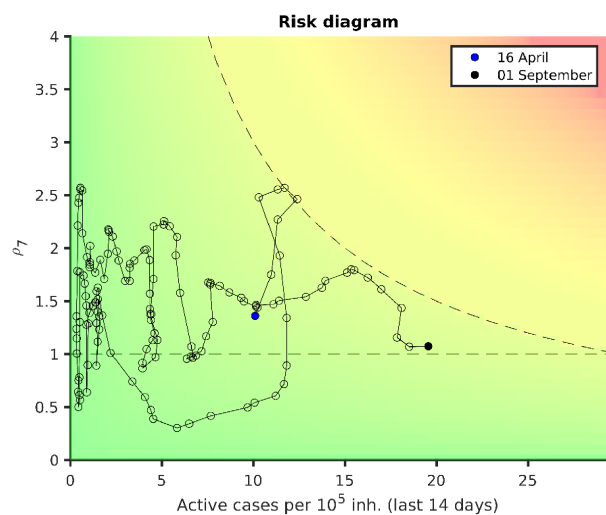
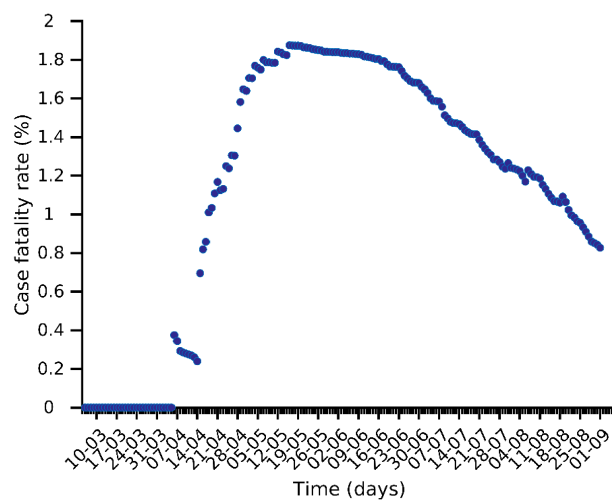
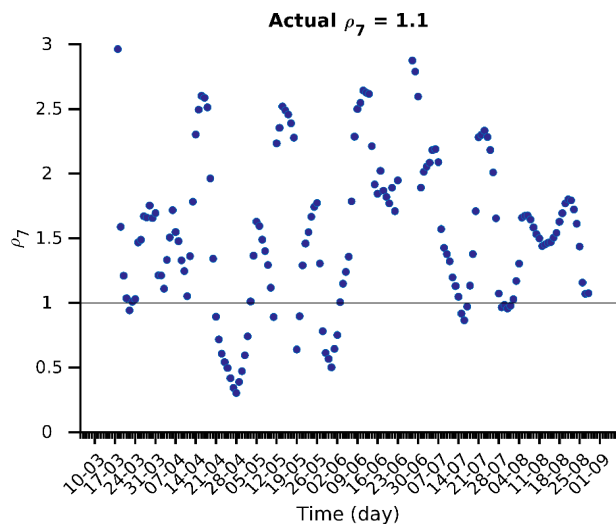
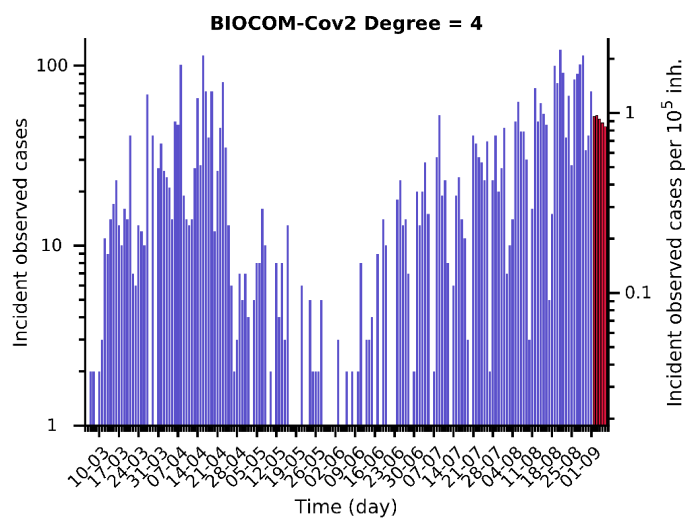
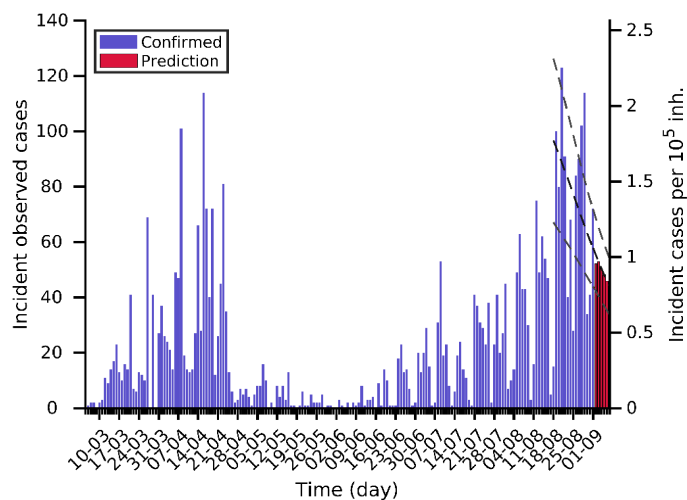
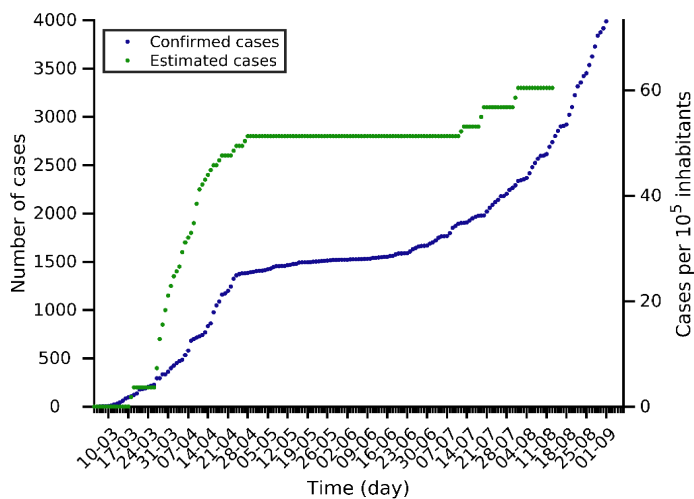
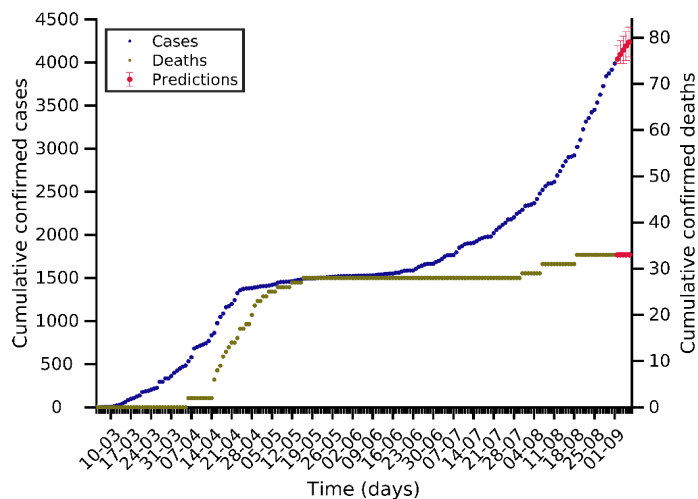
Luxembourg 01-09-2020. Pop: 0.6M. Cumulative incidence: 1067/10⁵



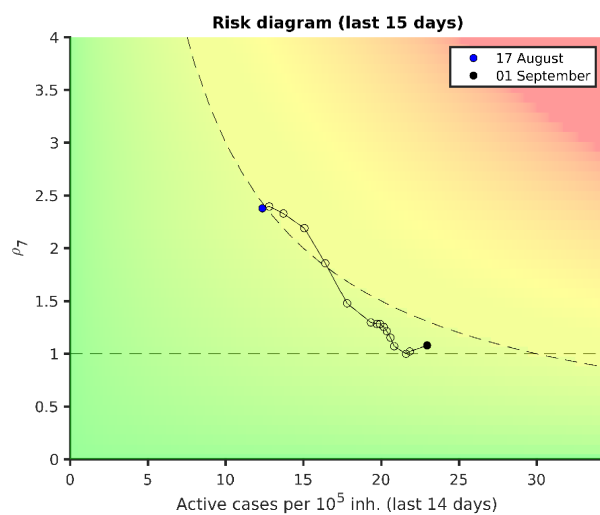
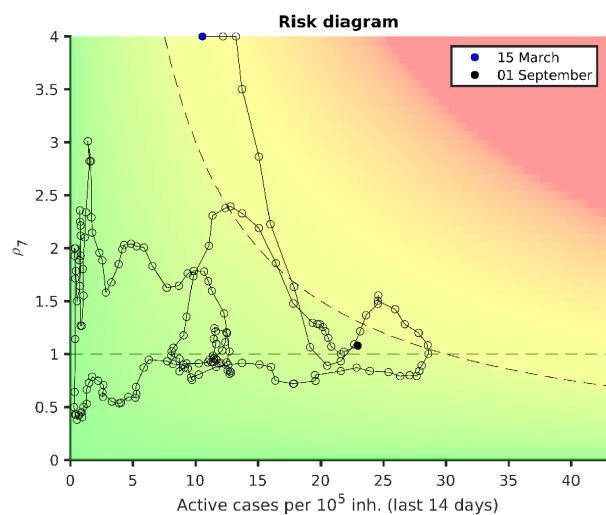
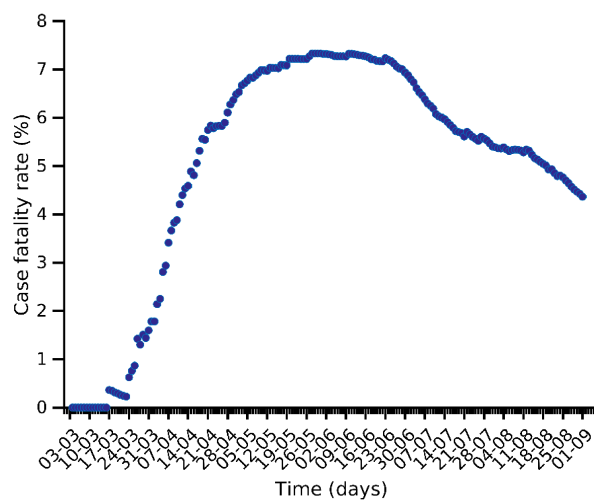
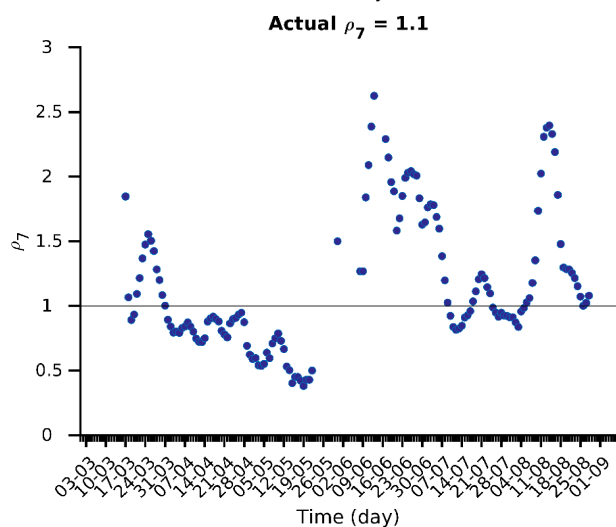
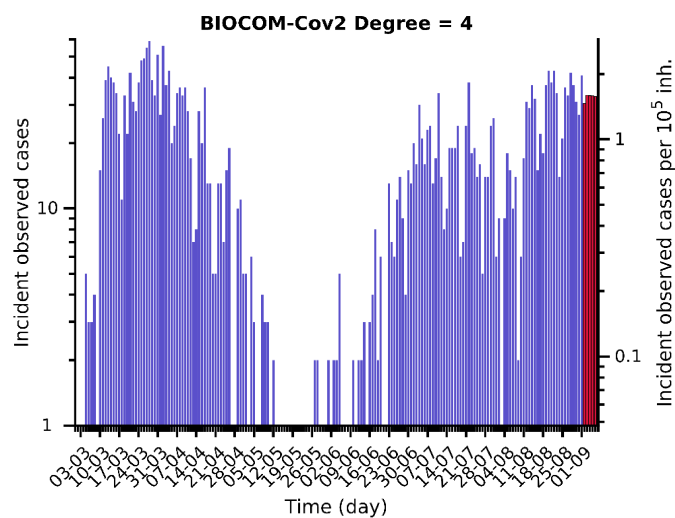
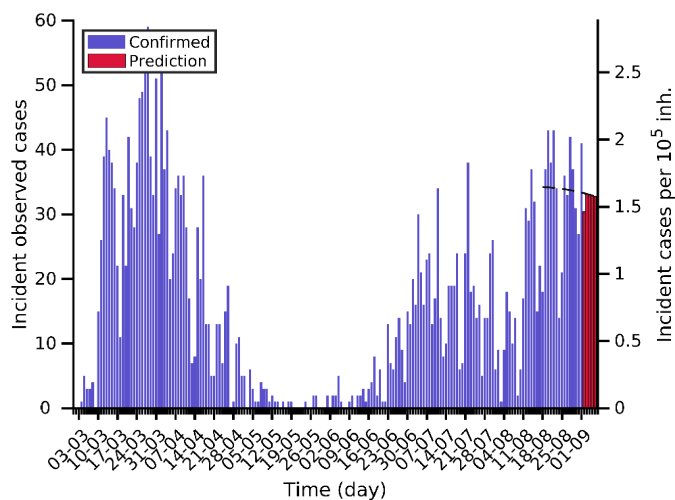
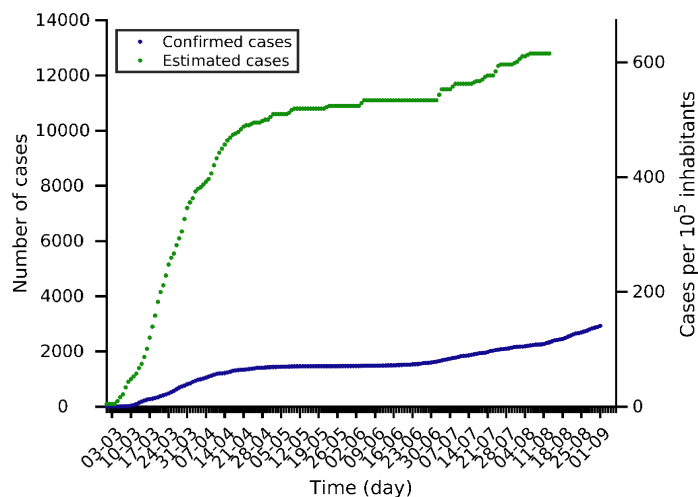
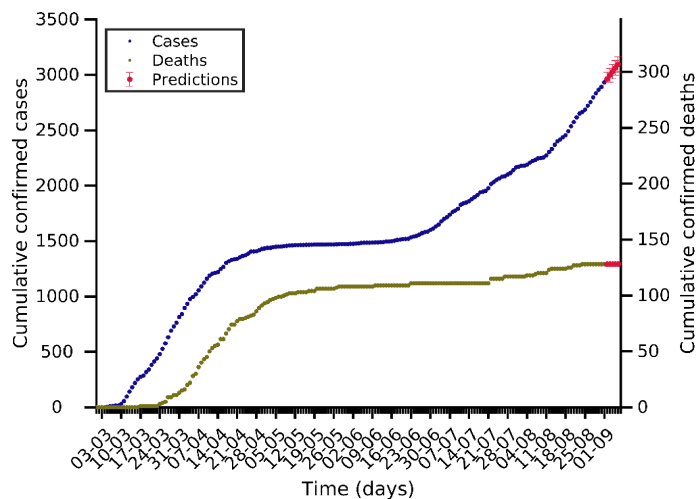
Hungary 01-09-2020. Pop: 9.7M. Cumulative incidence: 65/10⁵



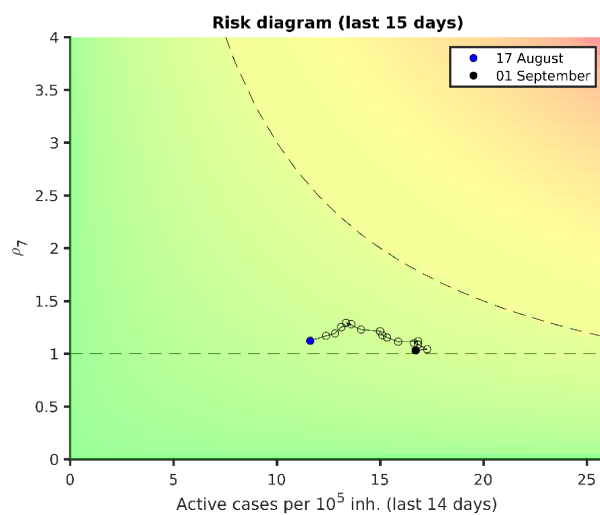
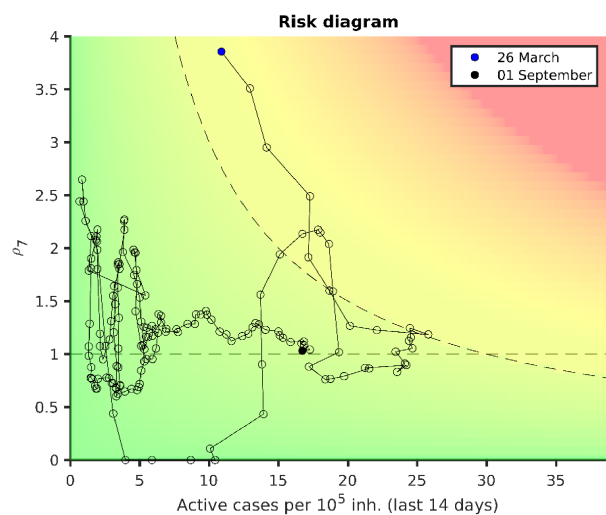
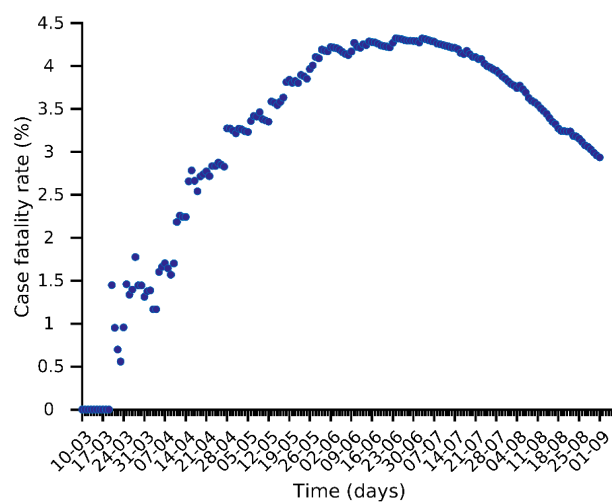
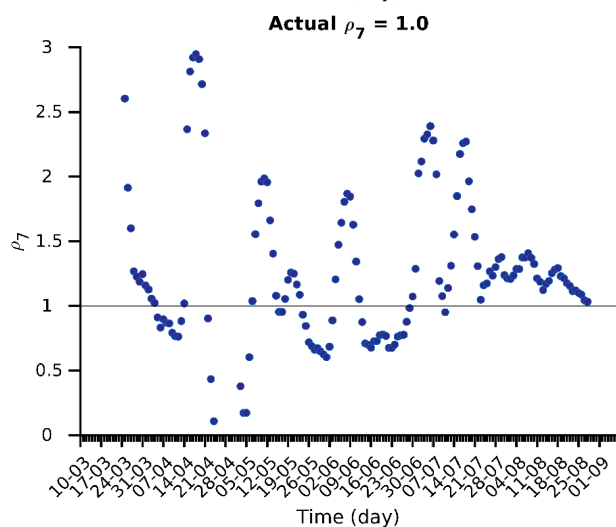
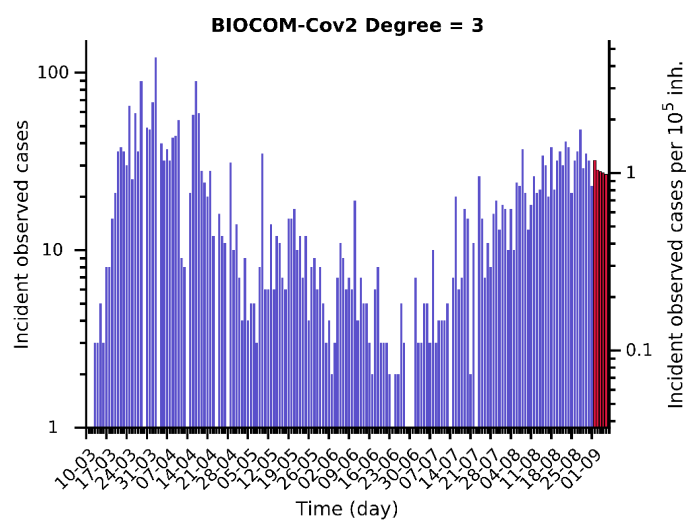
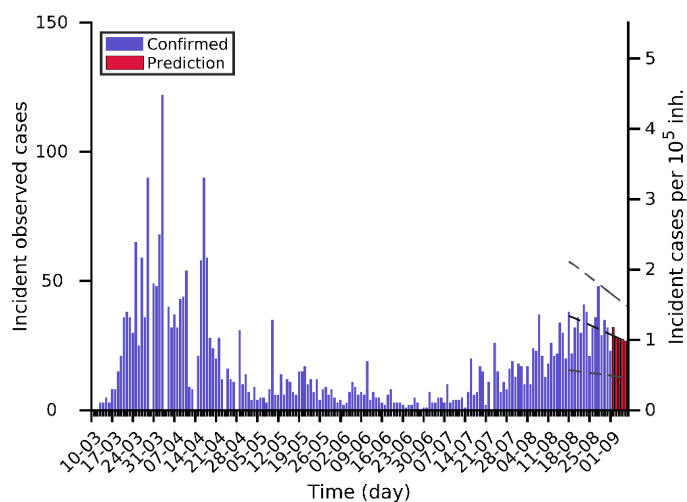
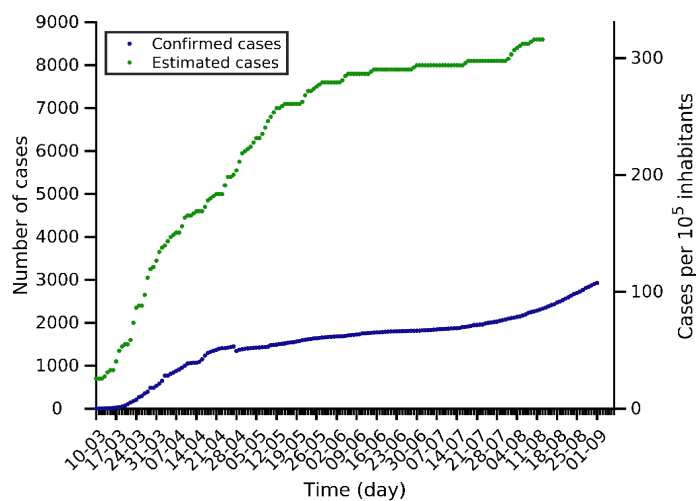
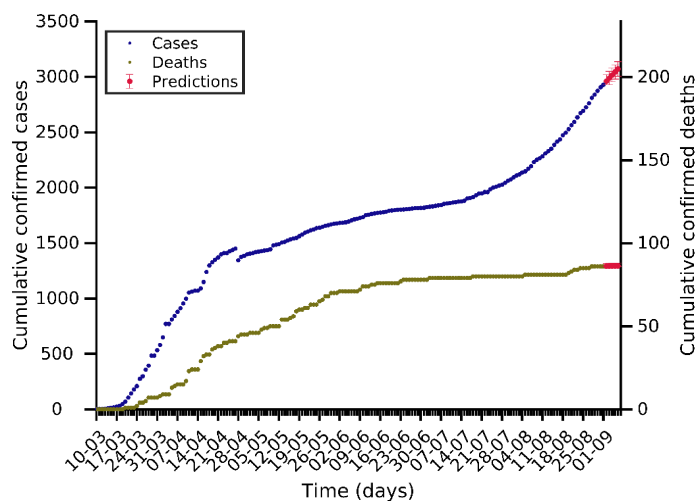
Slovakia 01-09-2020. Pop: 5.5M. Cumulative incidence: 73/10⁵



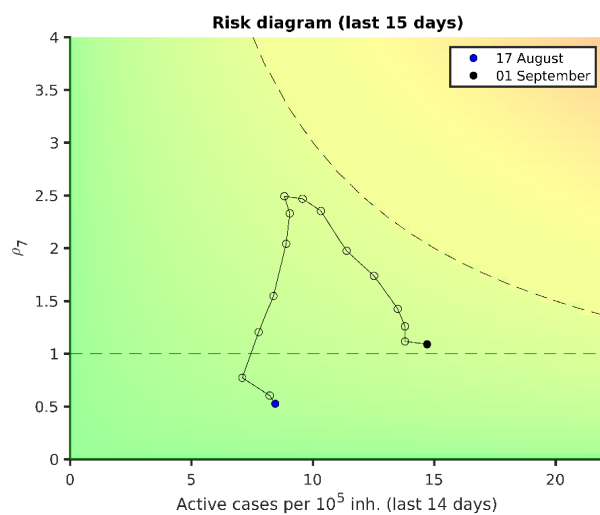
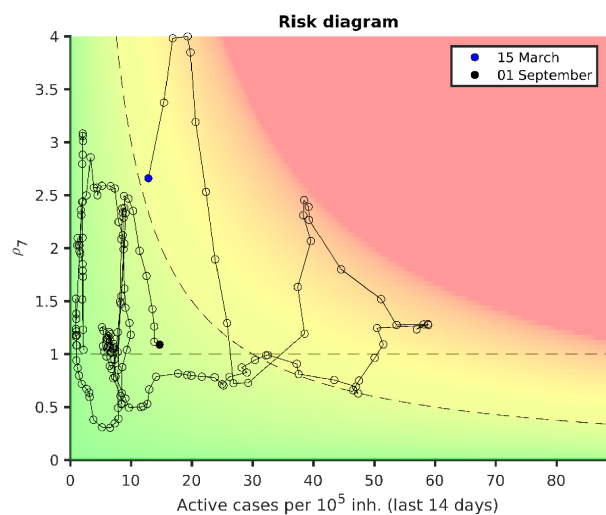
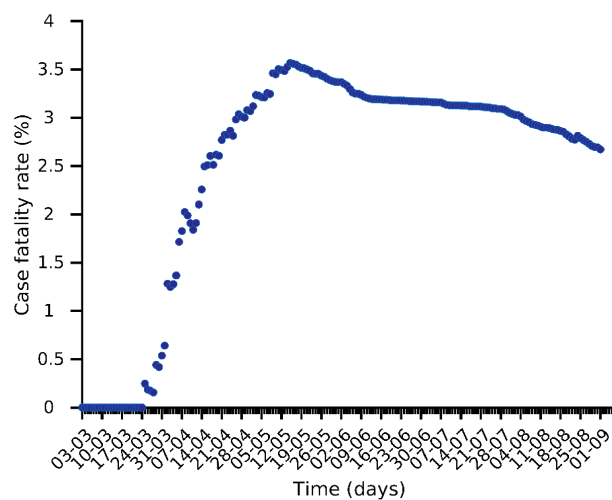
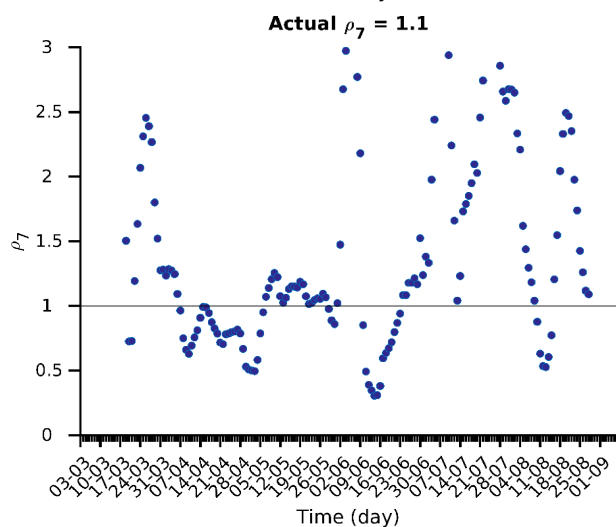
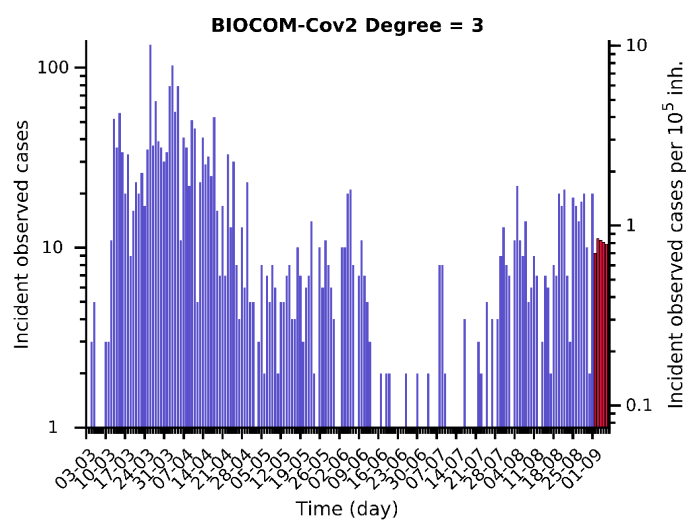
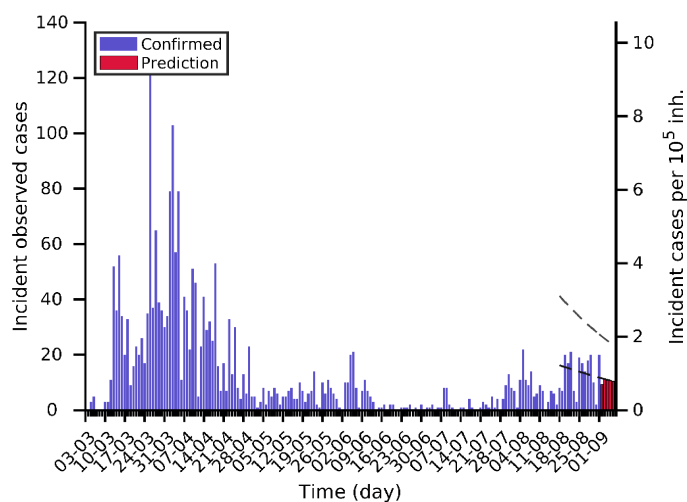
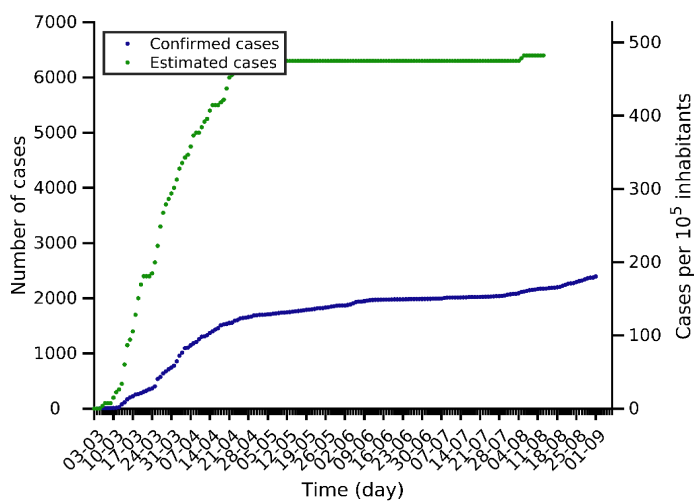
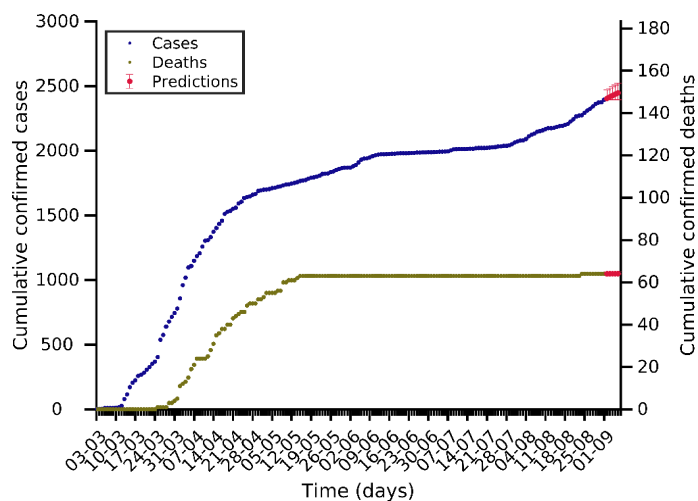
Slovenia 01-09-2020. Pop: 2.1M. Cumulative incidence: 141/10⁵



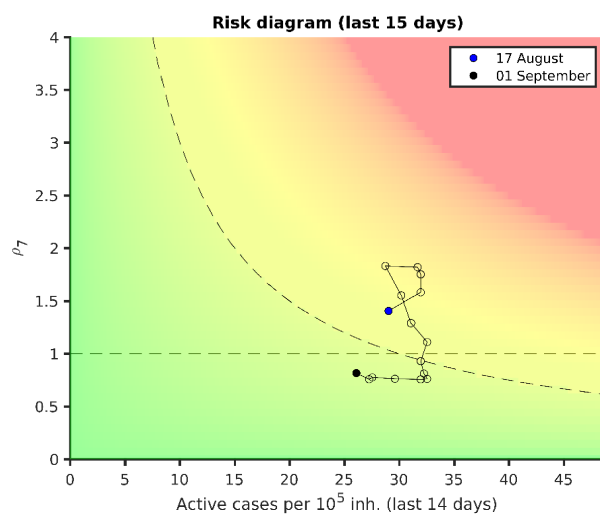
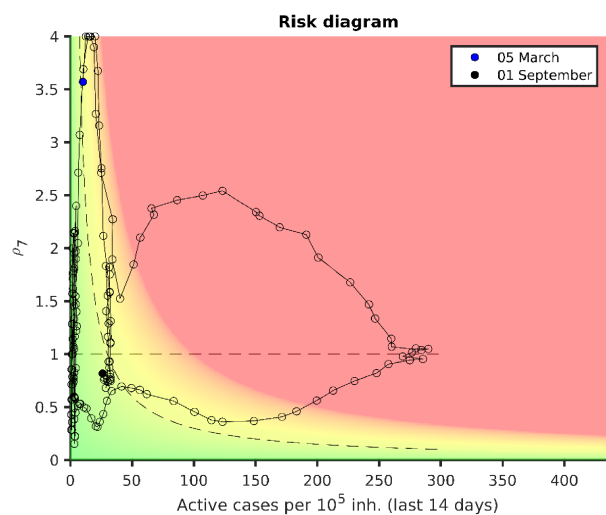
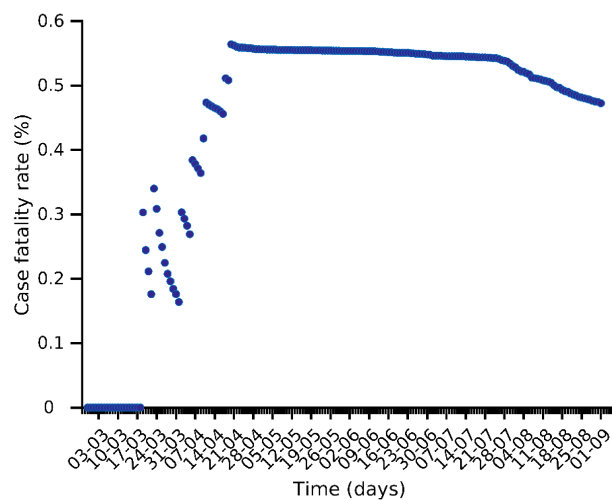
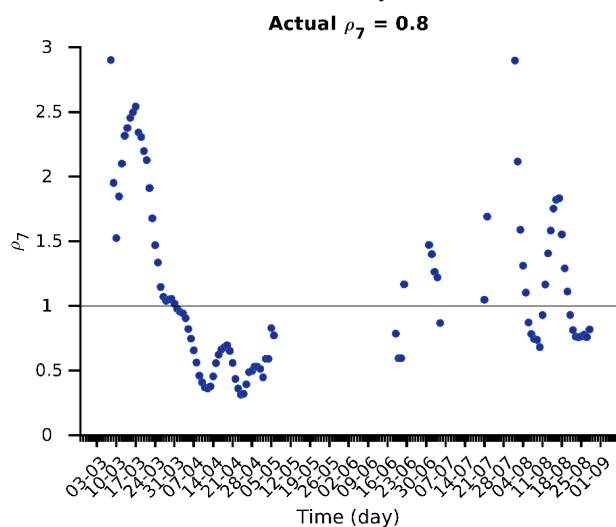
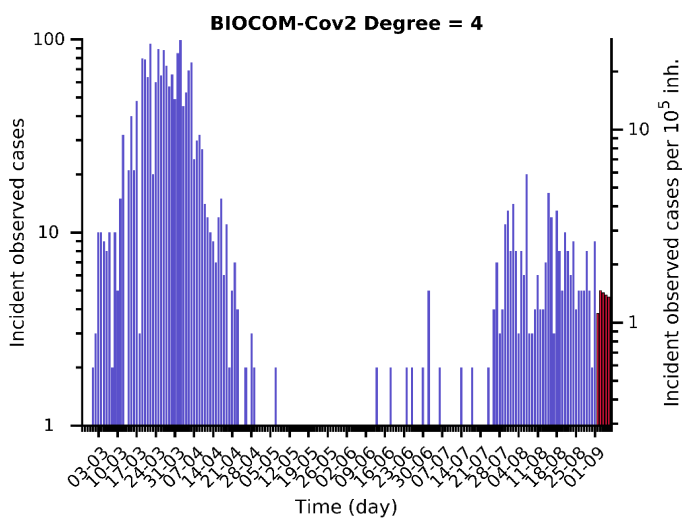
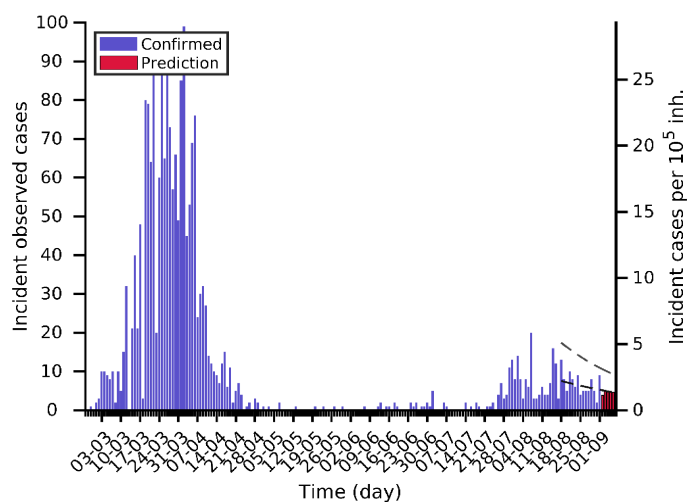
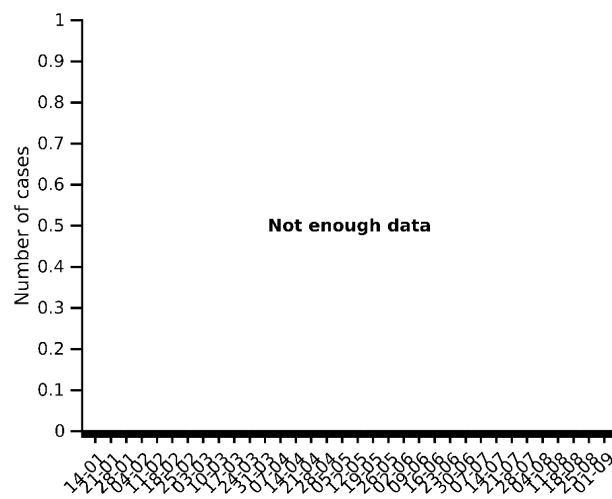
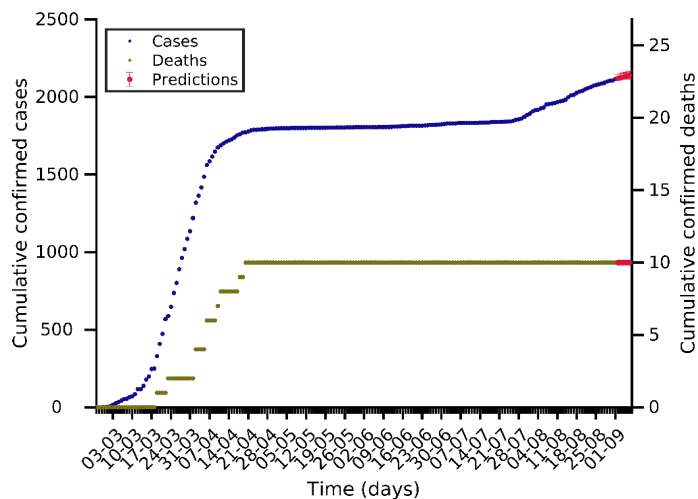
Lithuania 01-09-2020. Pop: 2.7M. Cumulative incidence: 108/10⁵



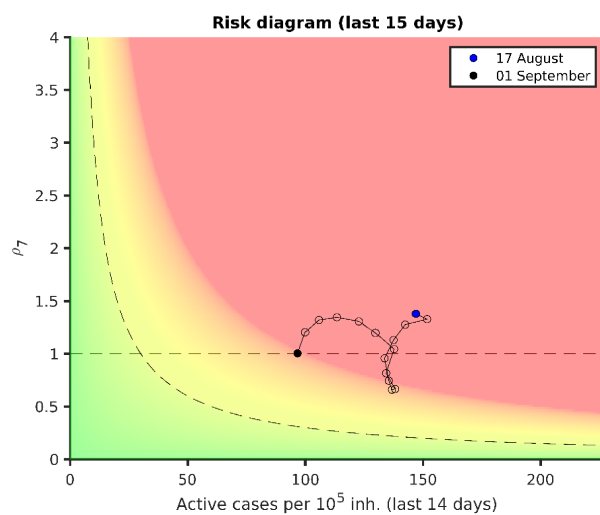
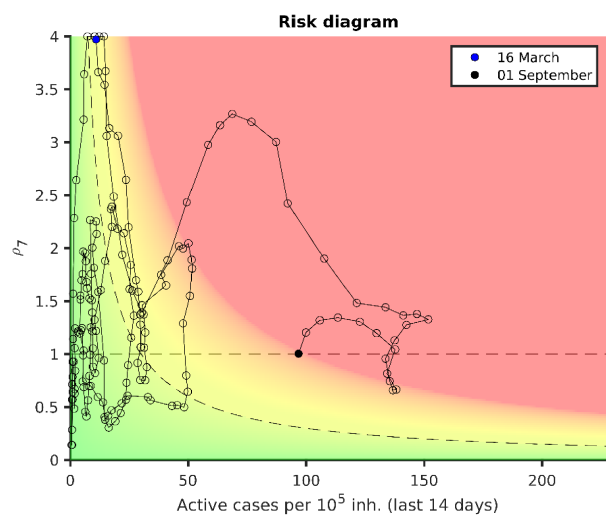
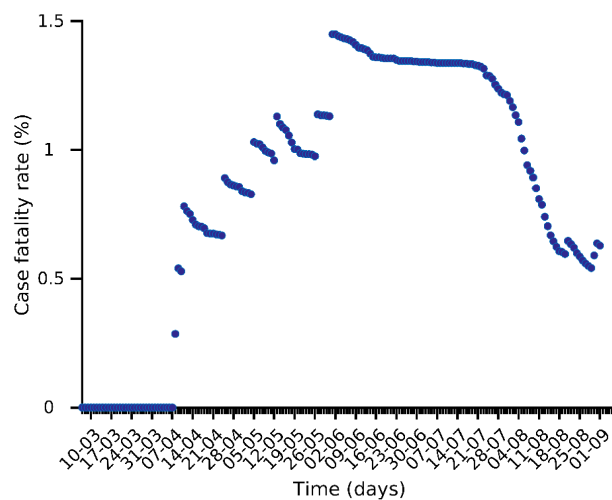
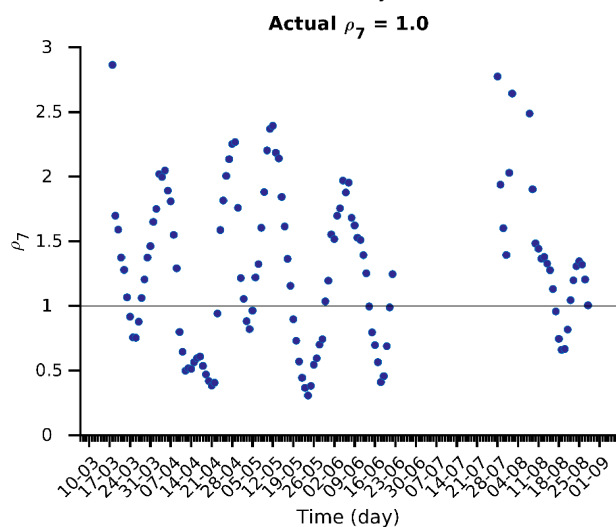
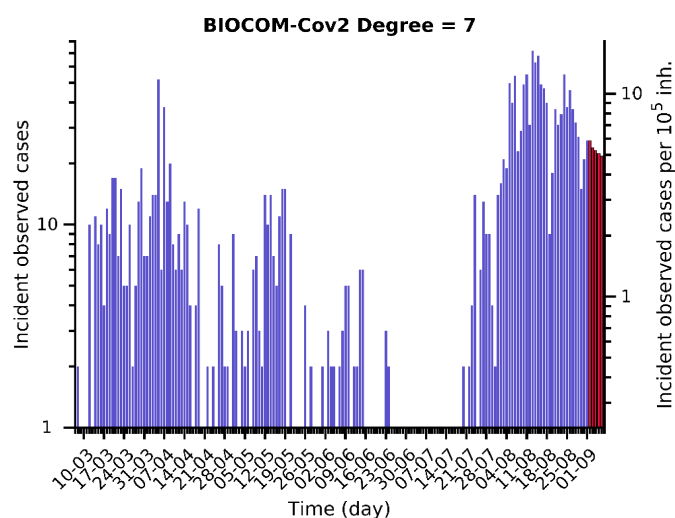
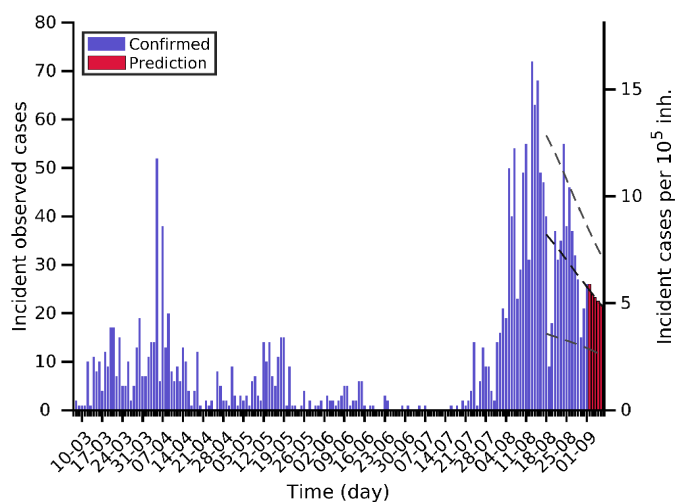
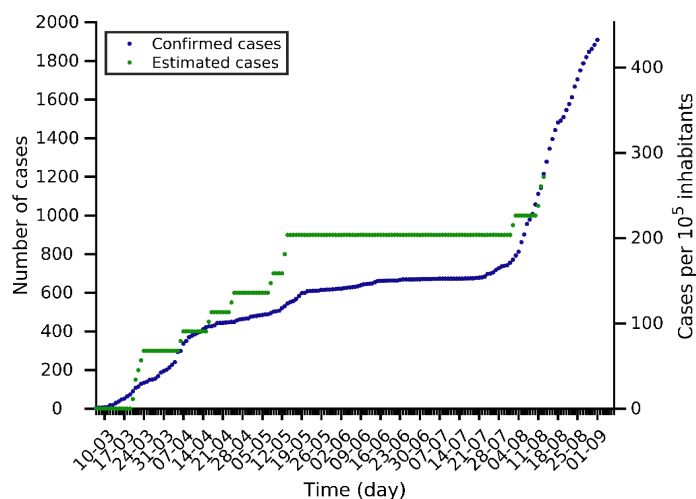
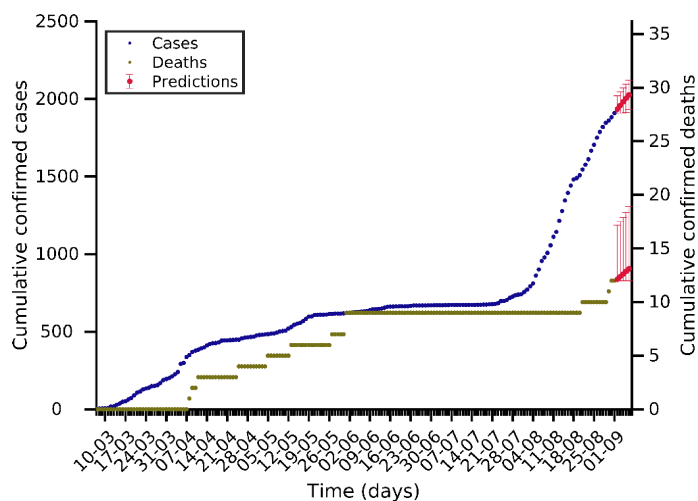
Estonia 01-09-2020. Pop: 1.3M. Cumulative incidence: 181/10⁵



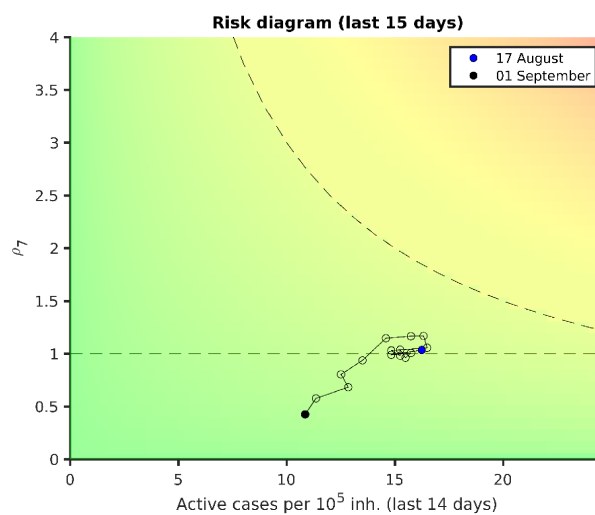
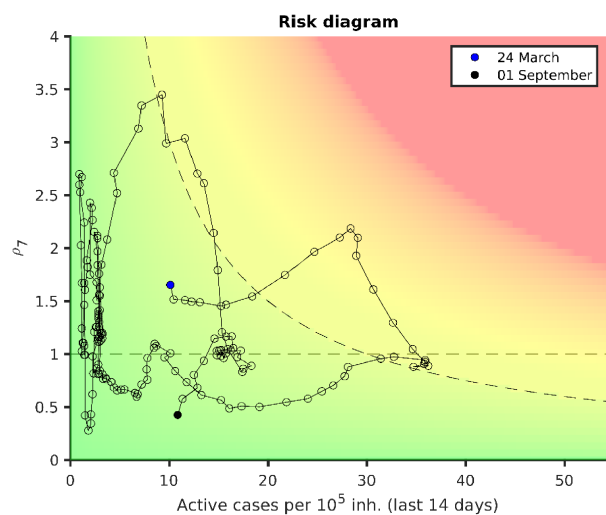
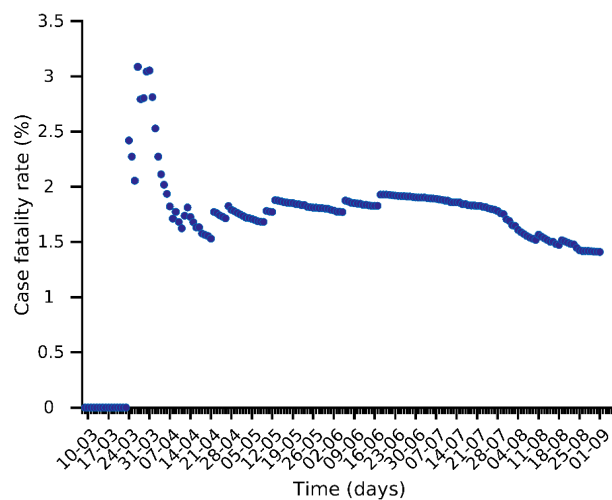
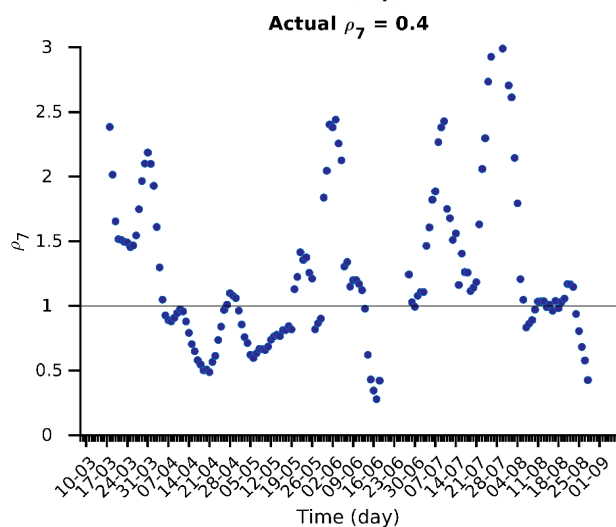
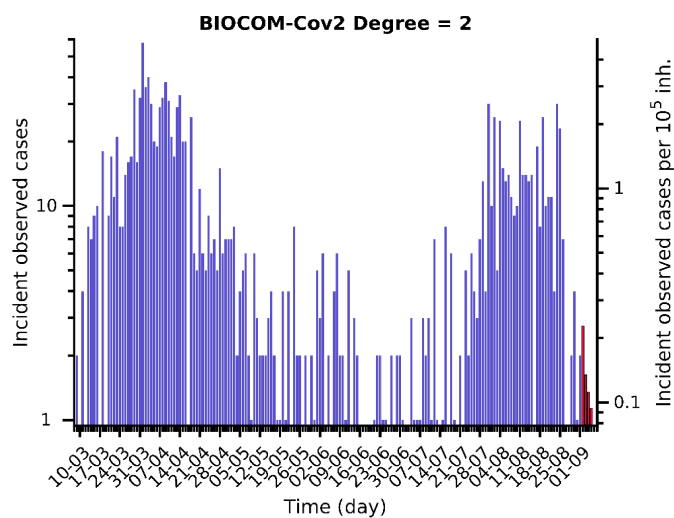
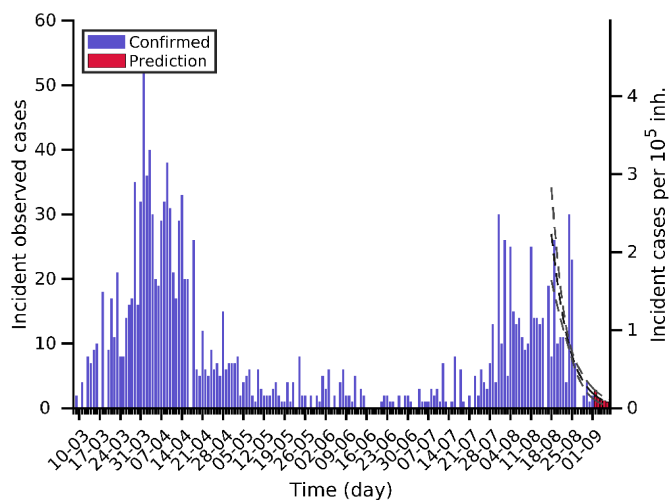
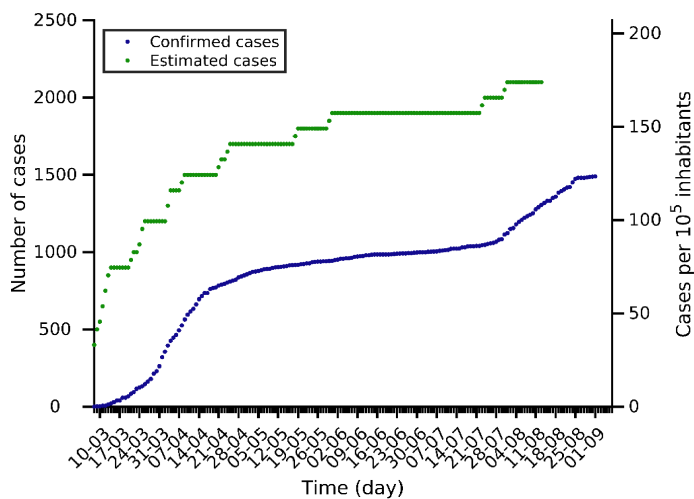
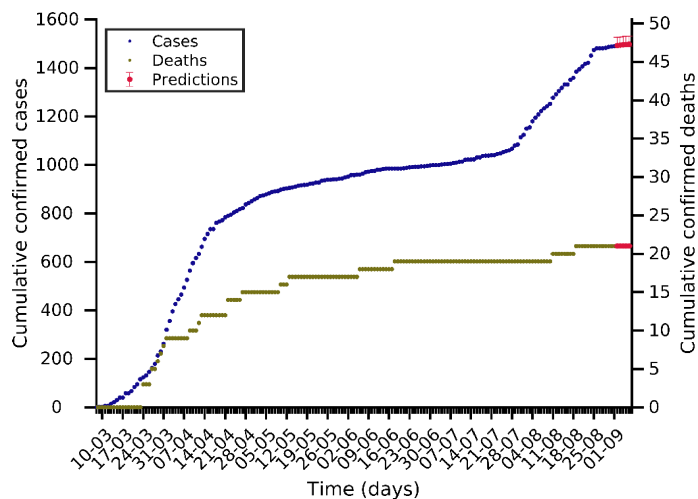
Iceland 01-09-2020. Pop: 0.3M. Cumulative incidence: 620/10⁵



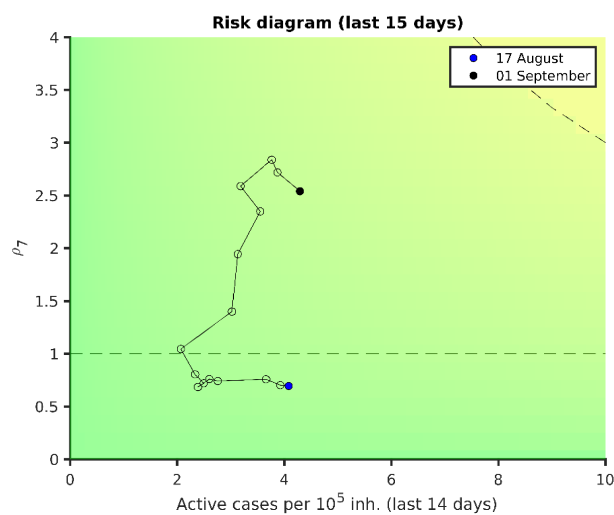
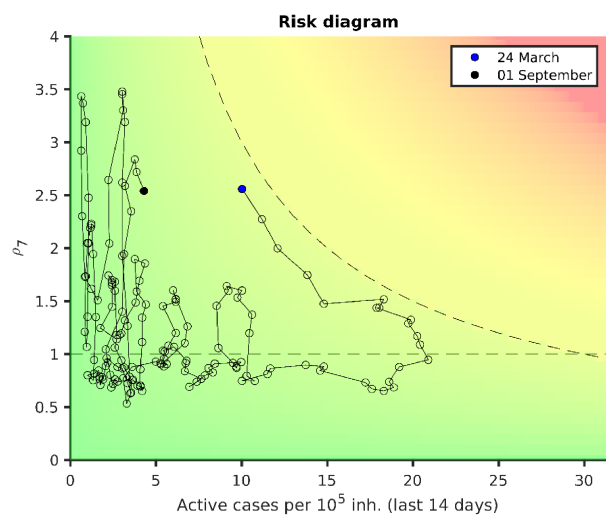
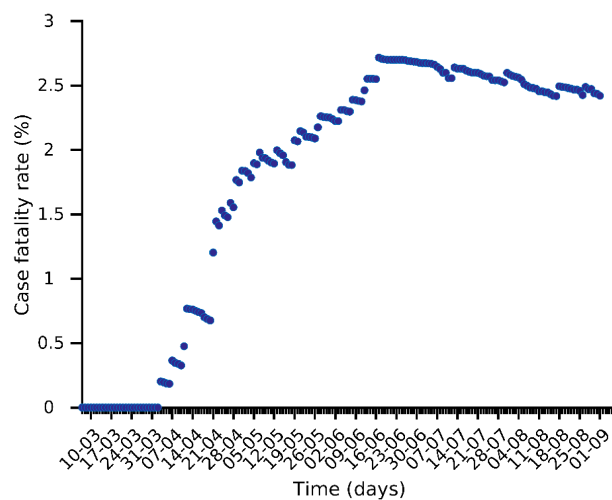
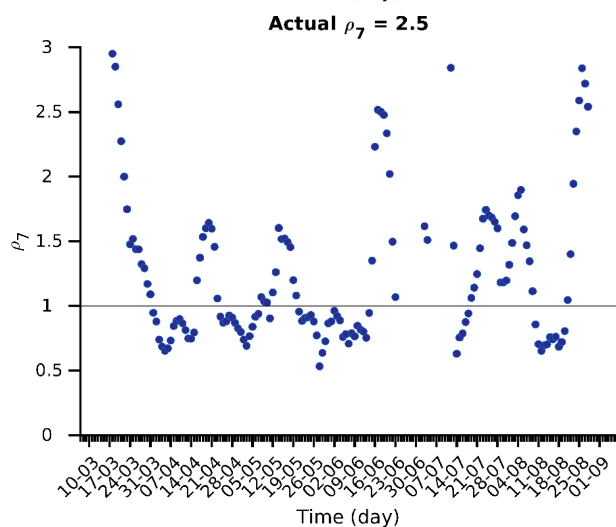
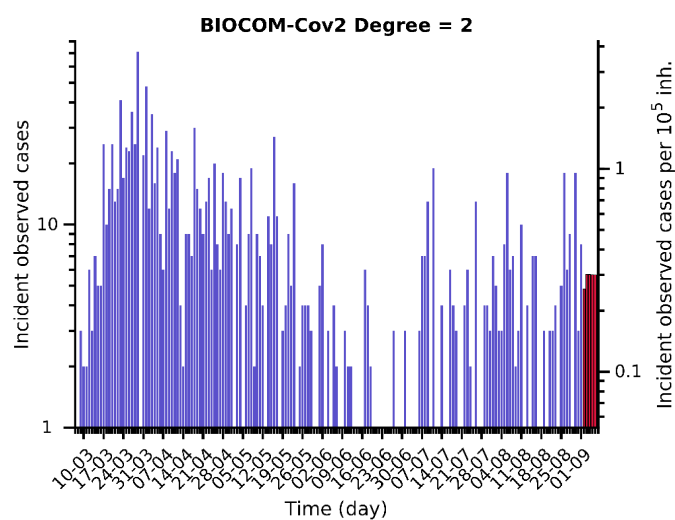
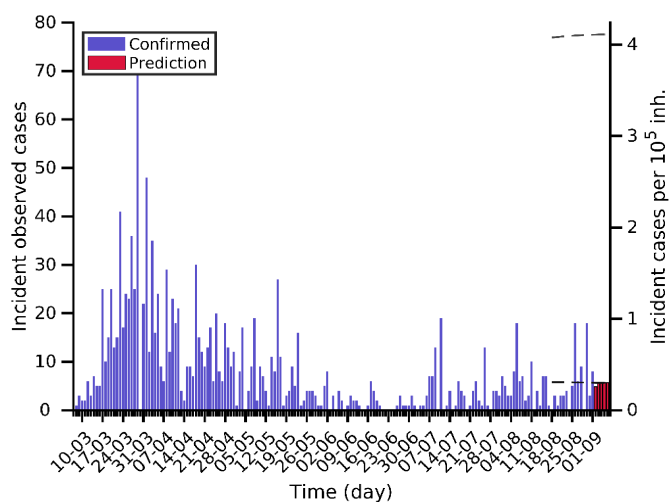
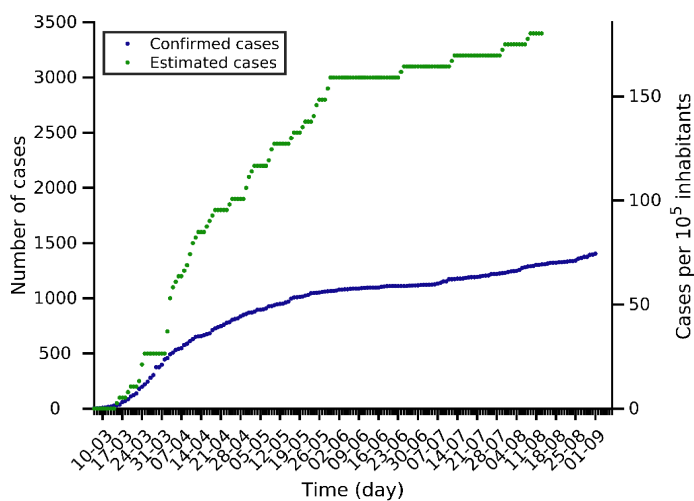
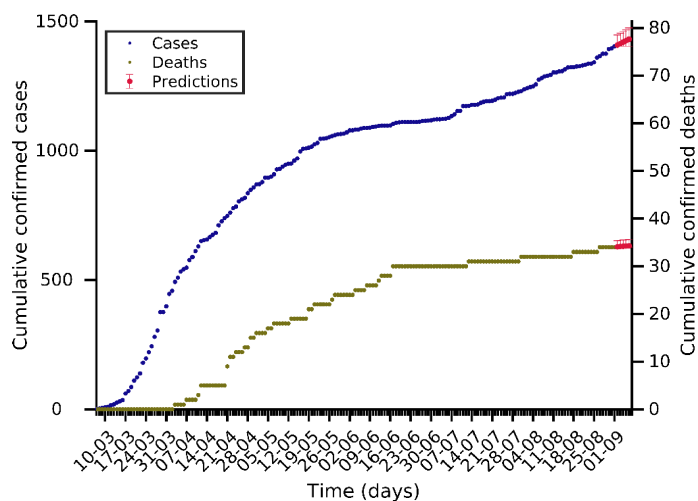
Malta 01-09-2020. Pop: 0.4M. Cumulative incidence: 432/10⁵



Cyprus 01-09-2020. Pop: 1.2M. Cumulative incidence: 123/10⁵

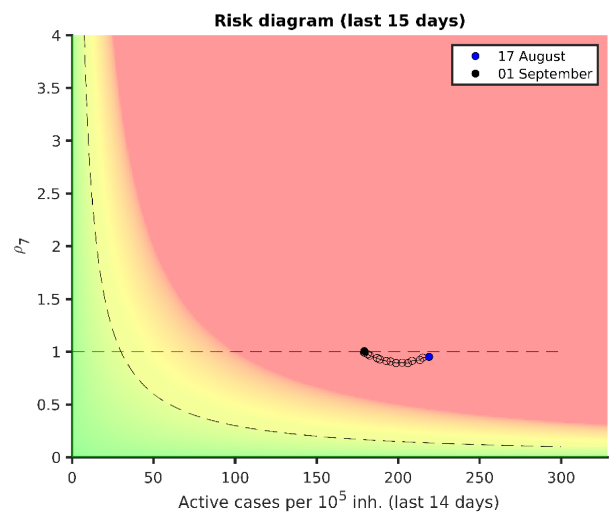
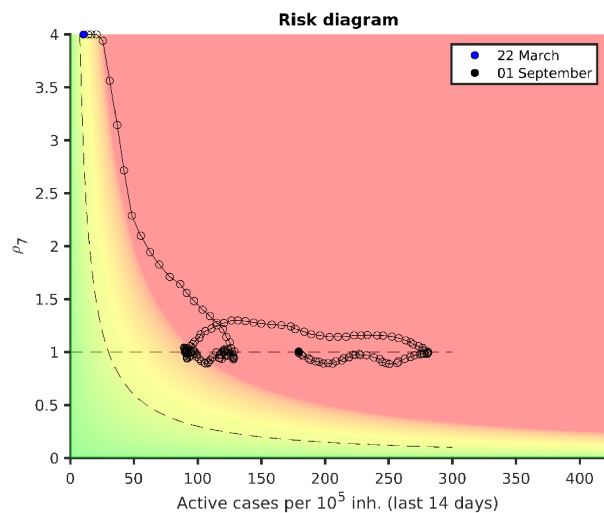
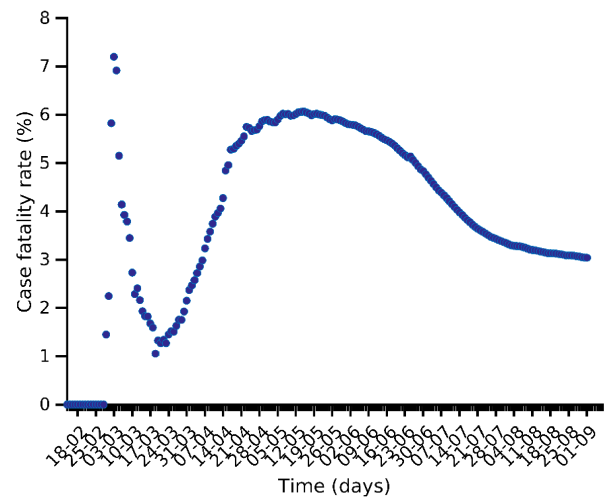
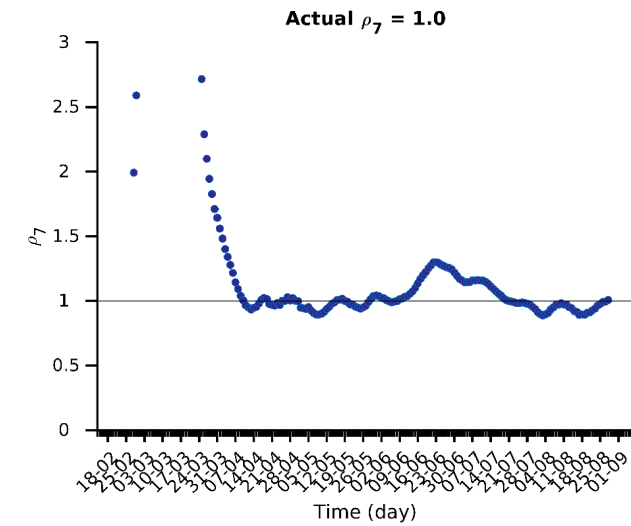
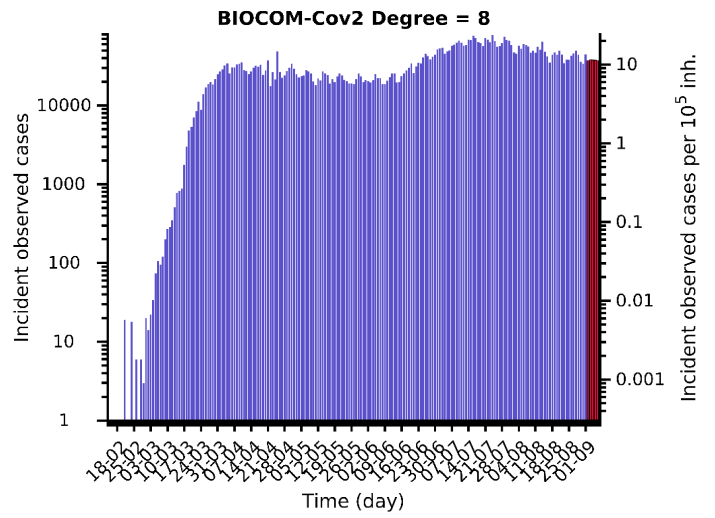
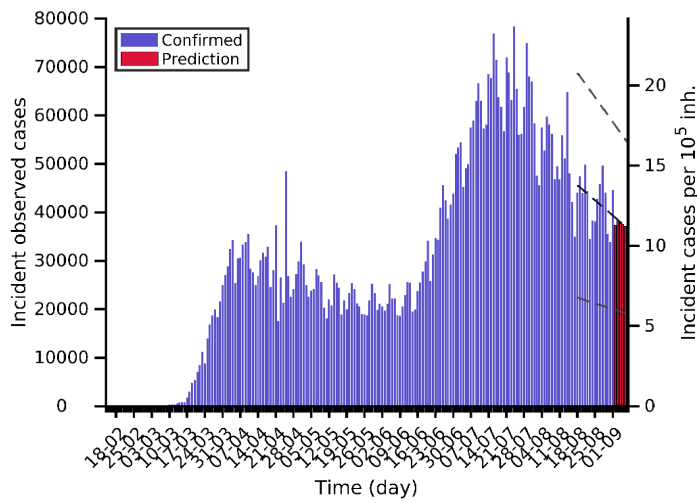
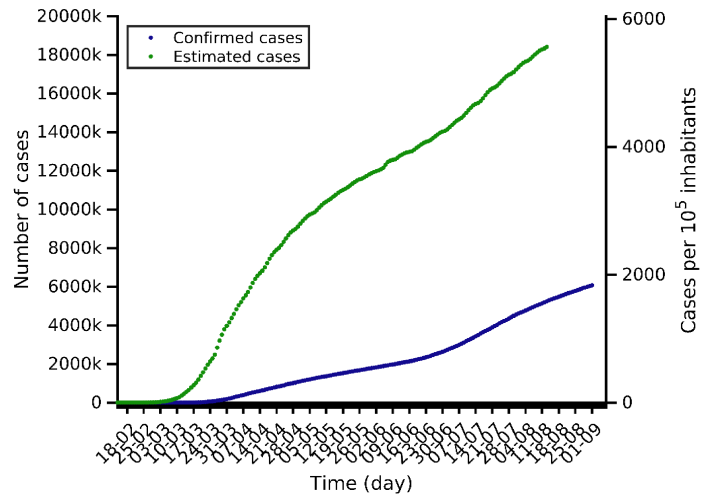
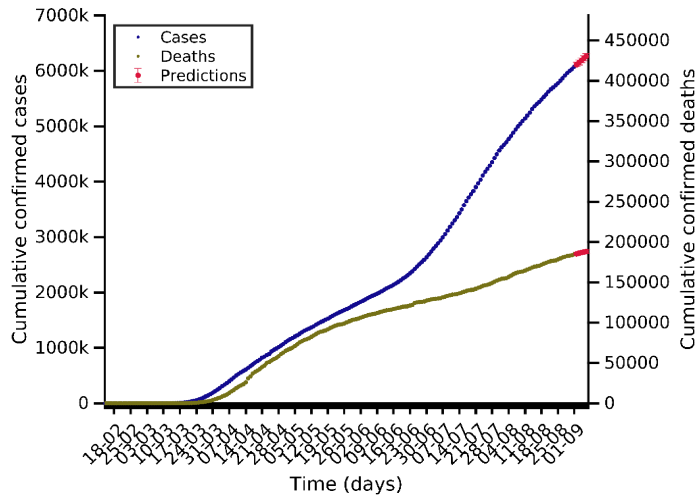


Latvia 01-09-2020. Pop: 1.9M. Cumulative incidence: 74/10⁵

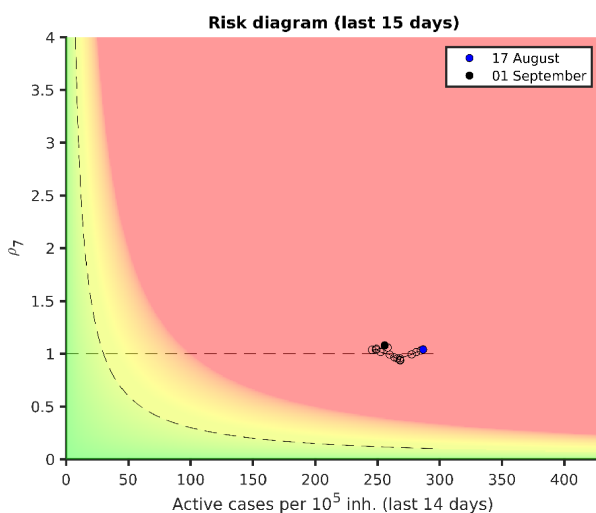
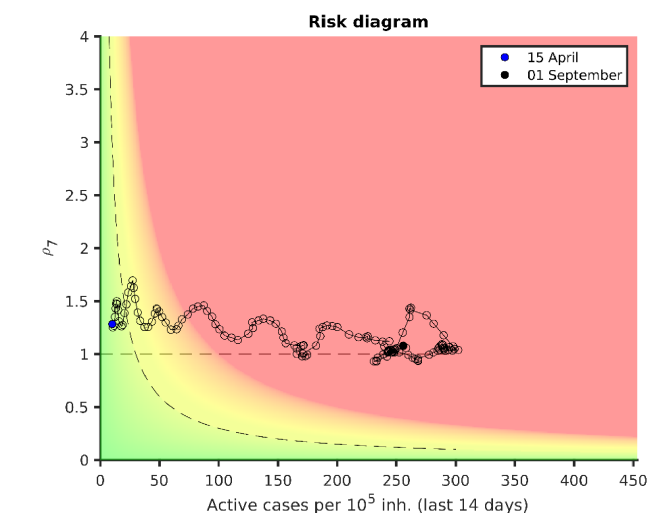
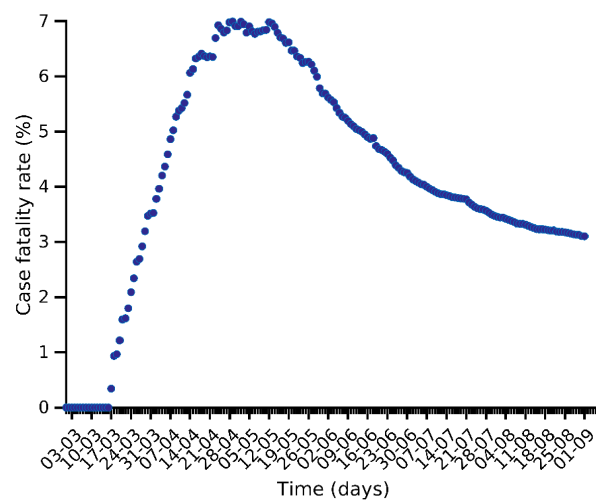
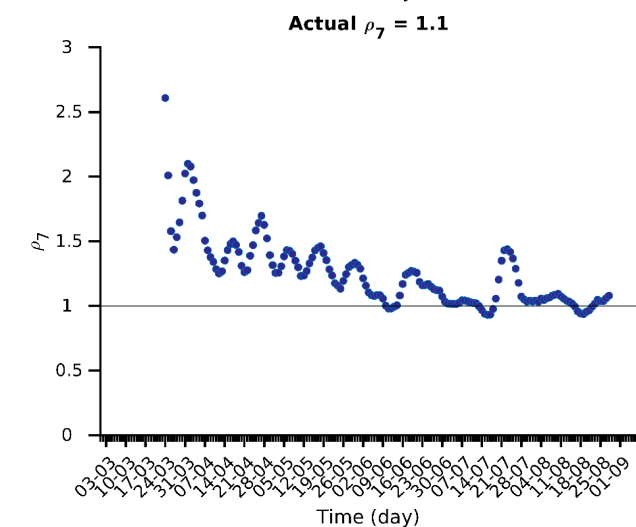
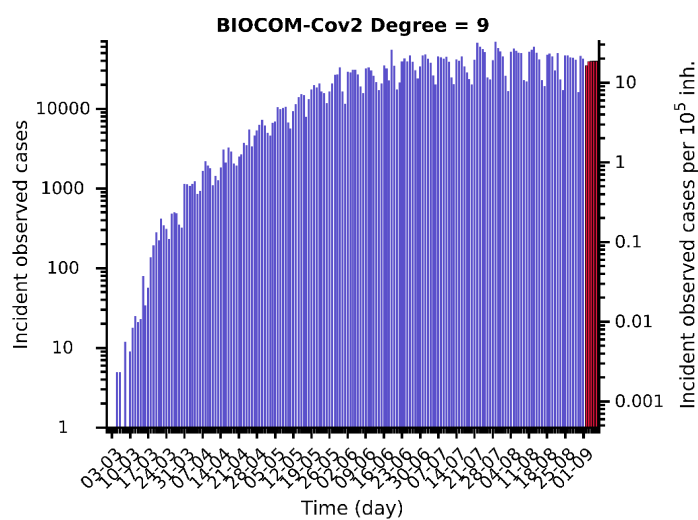
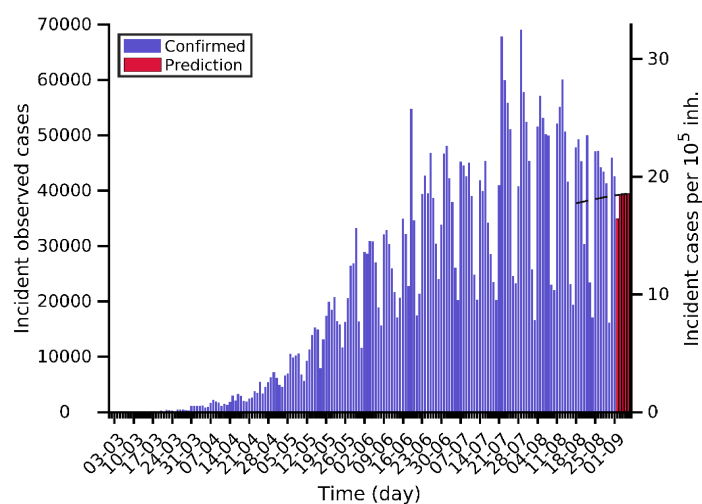
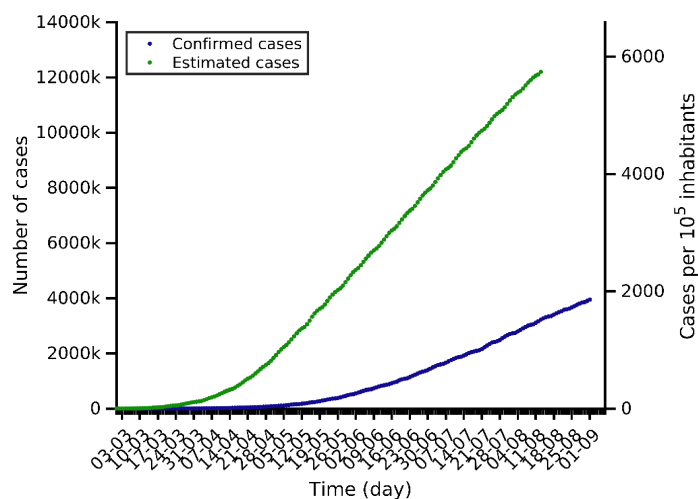
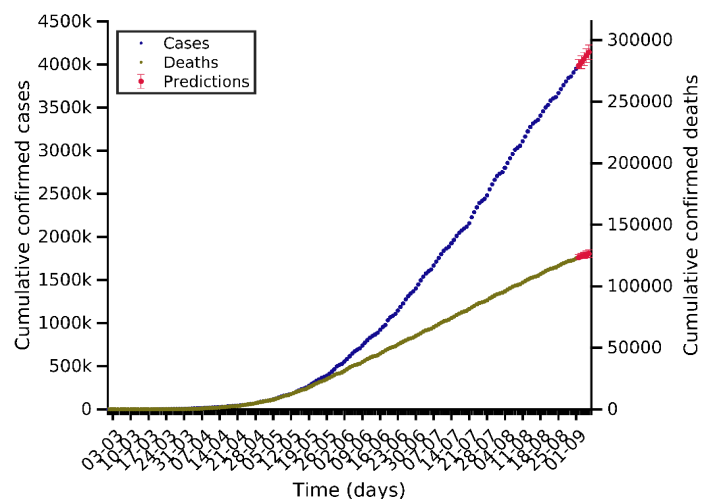


(2) Analysis and prediction of COVID-19 for other countries

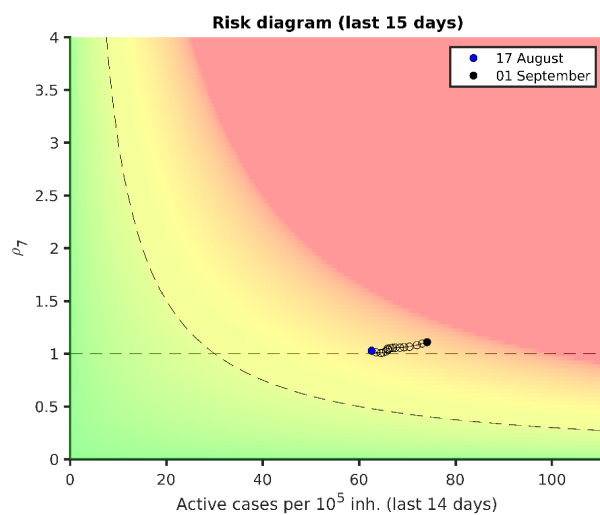
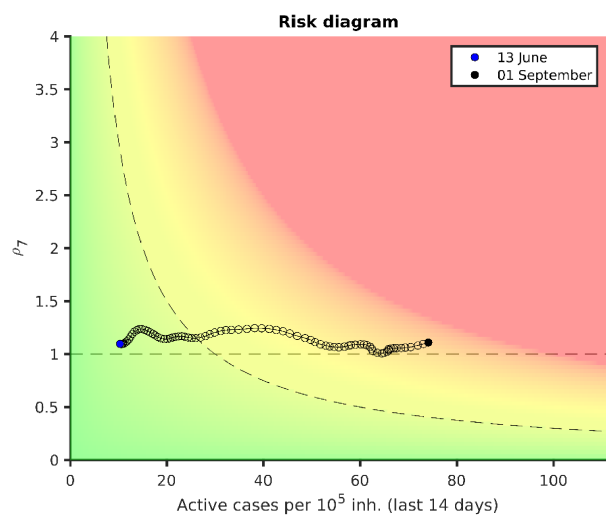
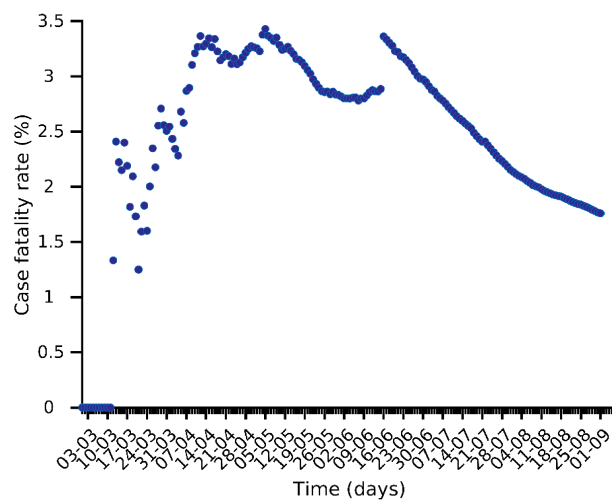
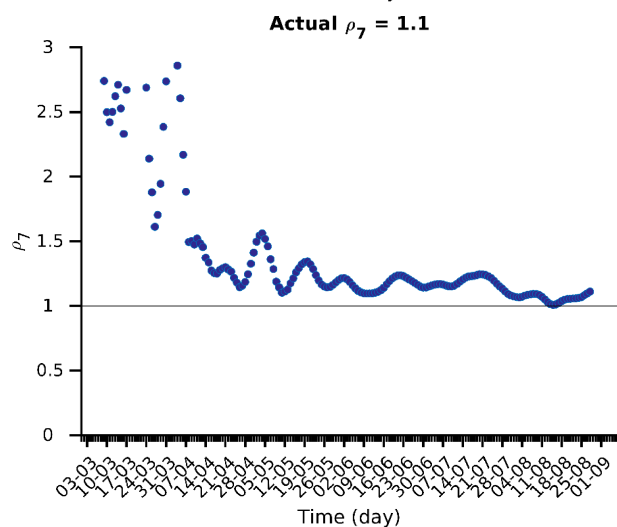
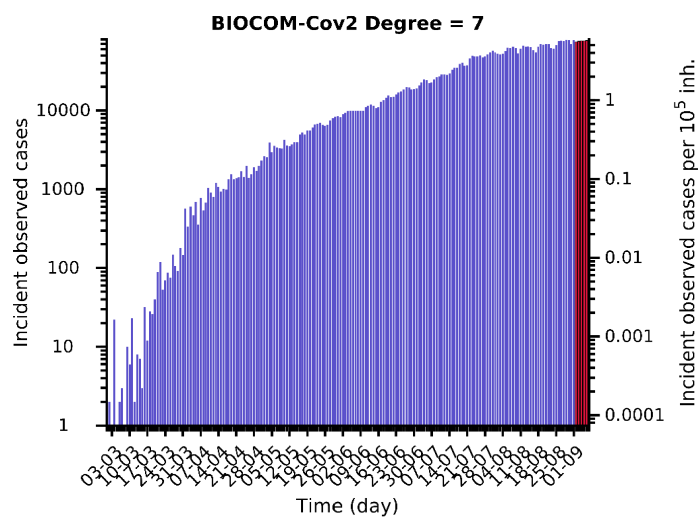
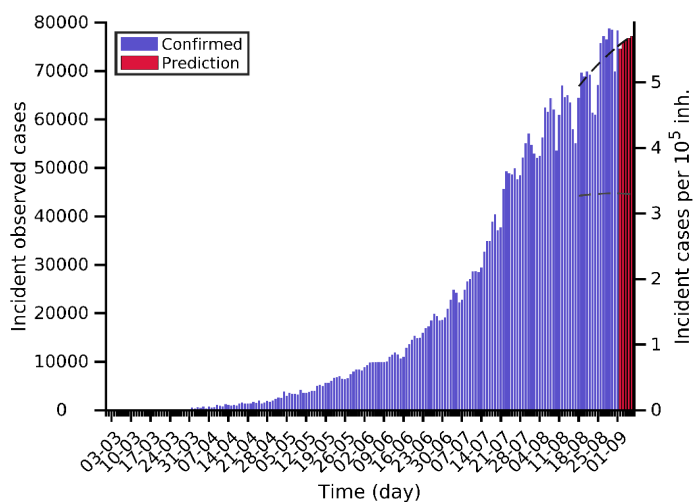
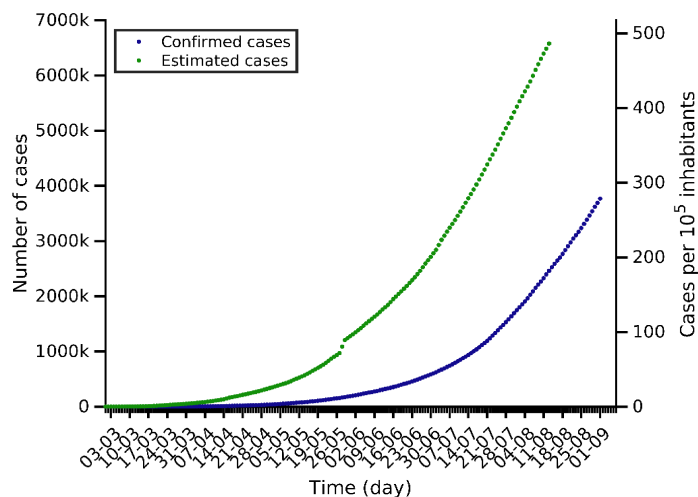
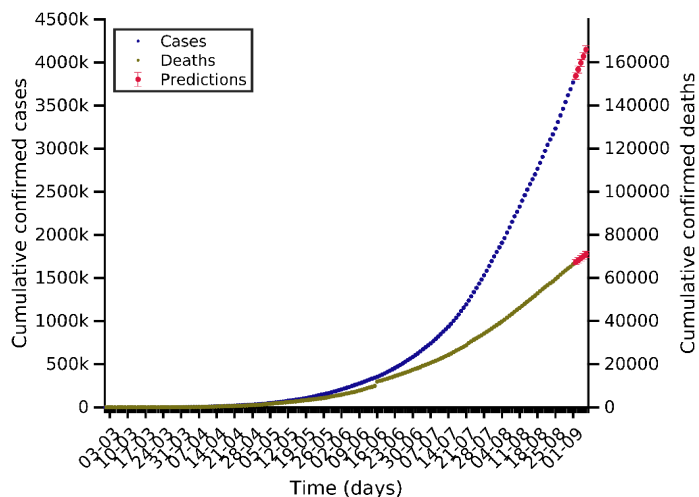
USA 01-09-2020. Pop: 331.0M. Cumulative incidence: 1836/10⁵



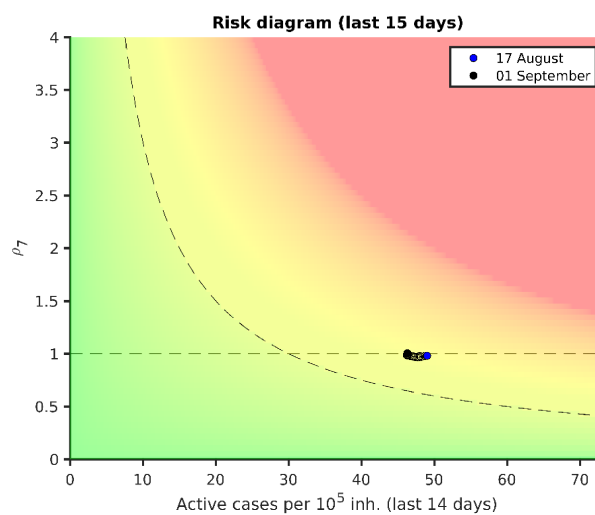
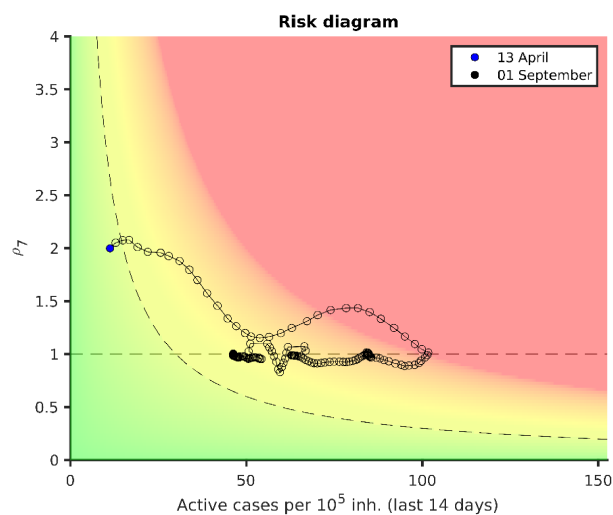
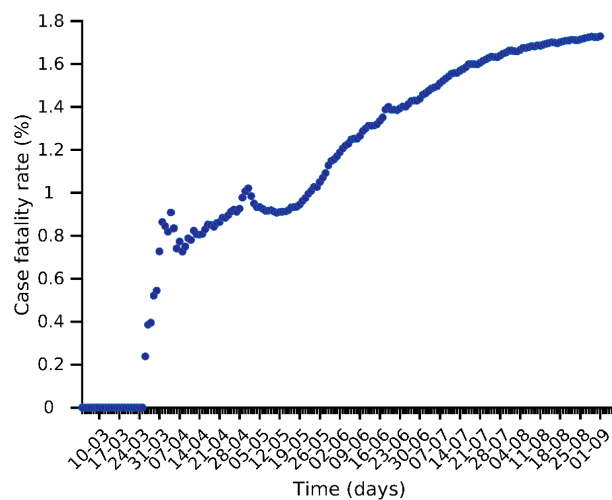
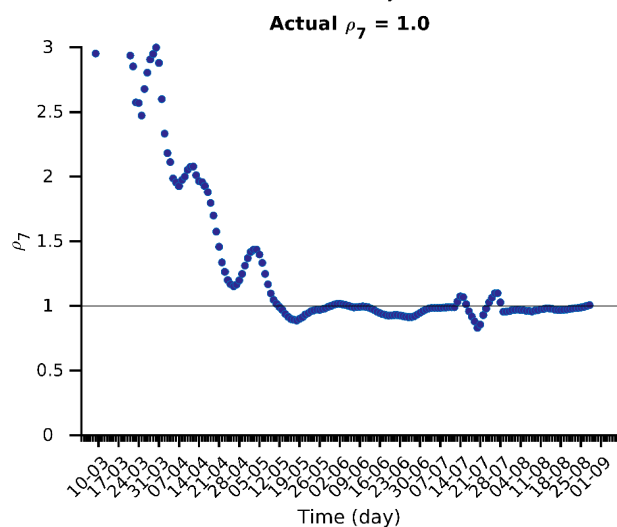
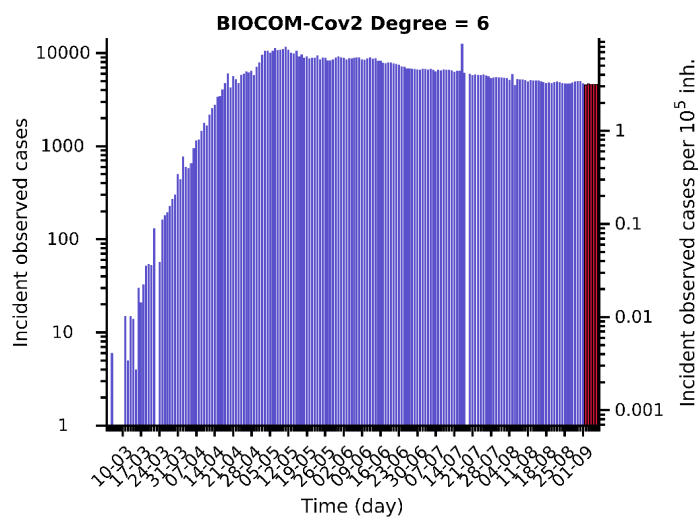
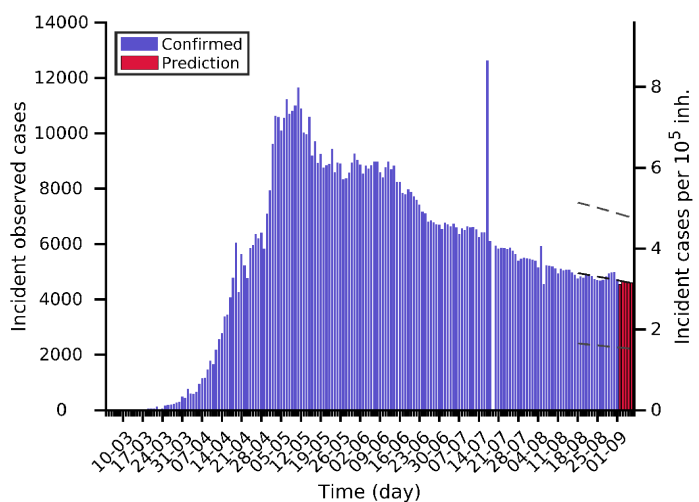
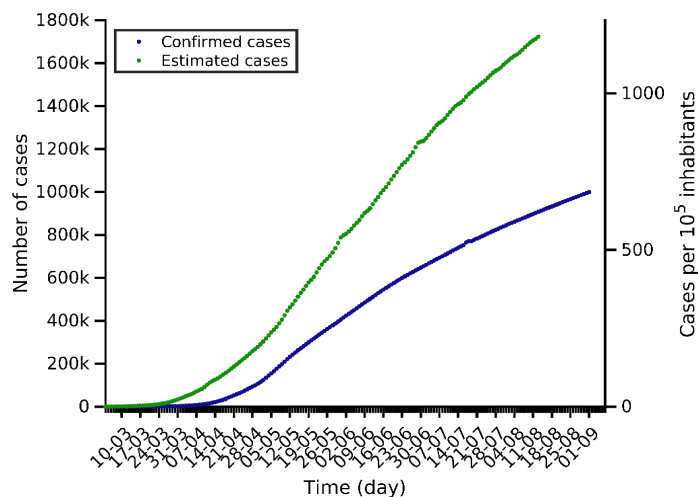
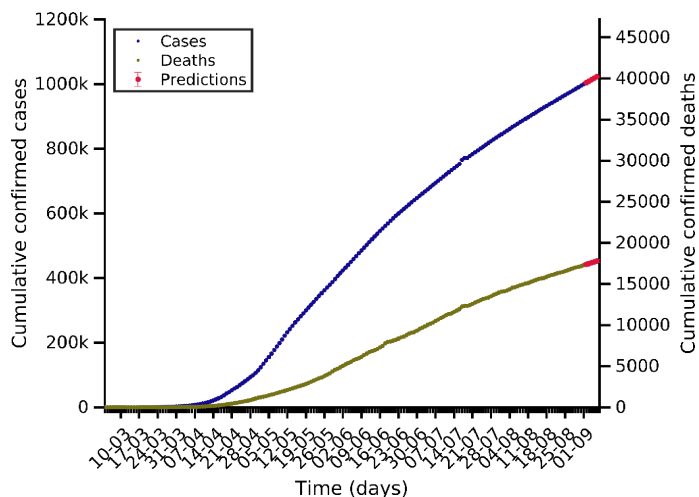
Brazil 01-09-2020. Pop: 212.6M. Cumulative incidence: 1859/10⁵



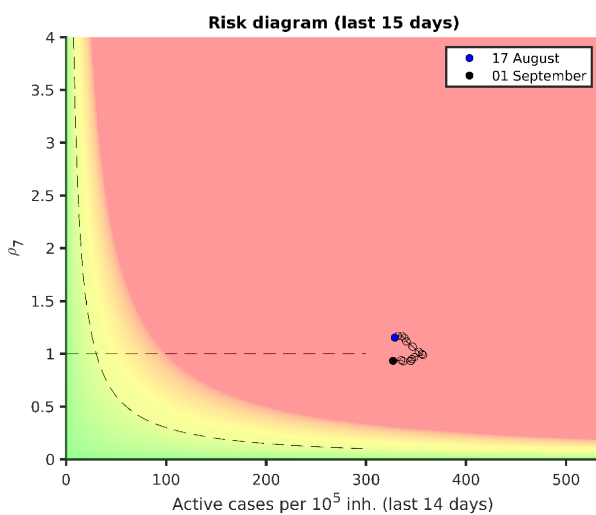
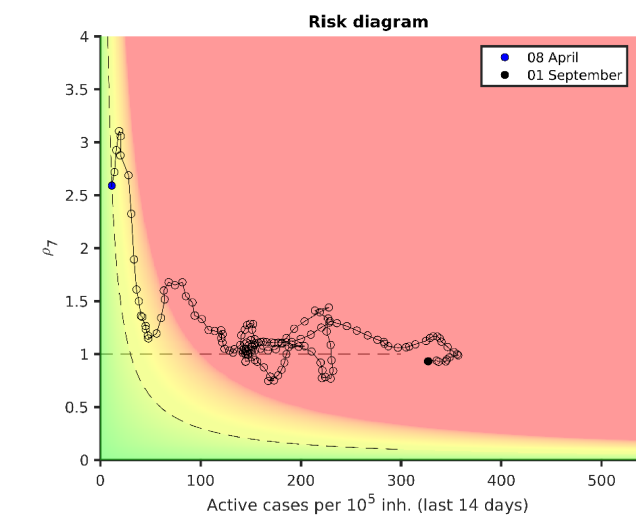
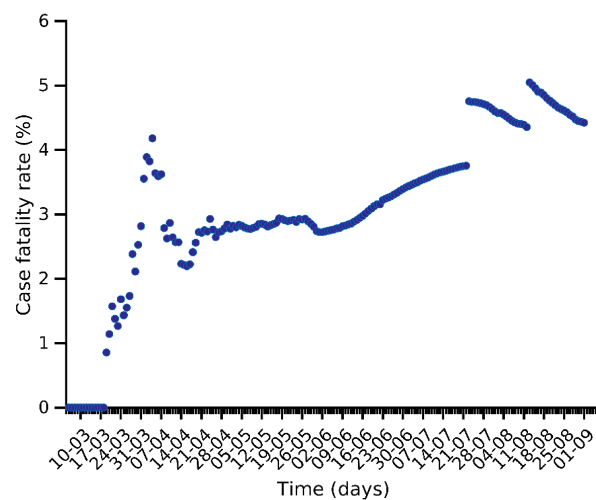
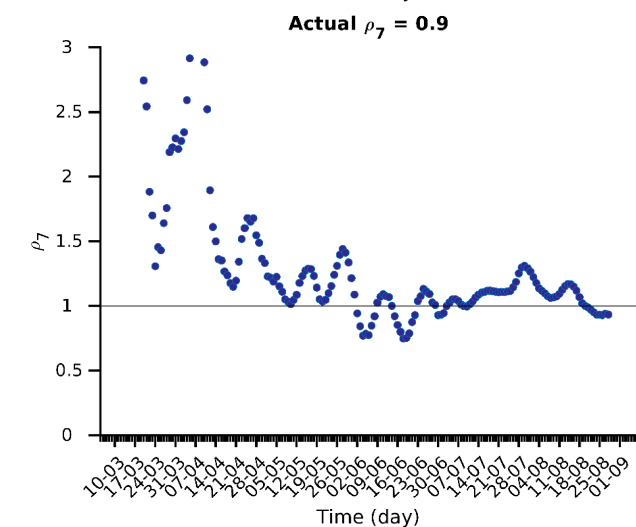
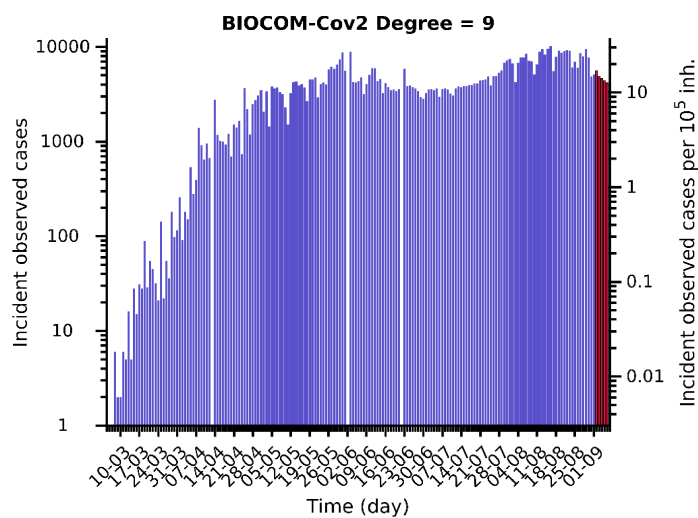
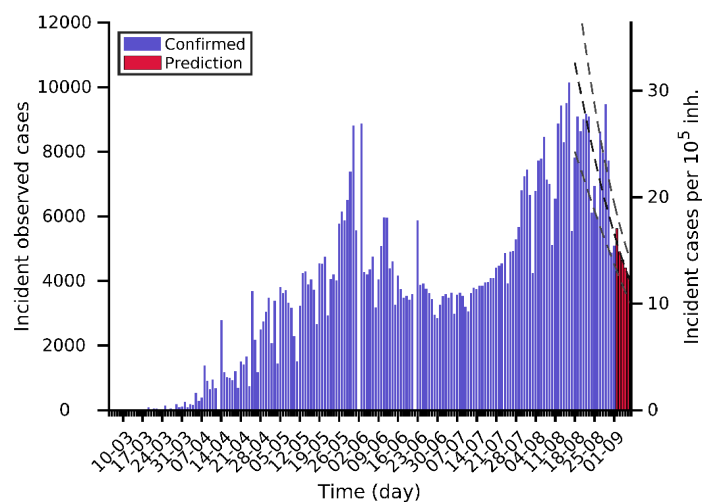
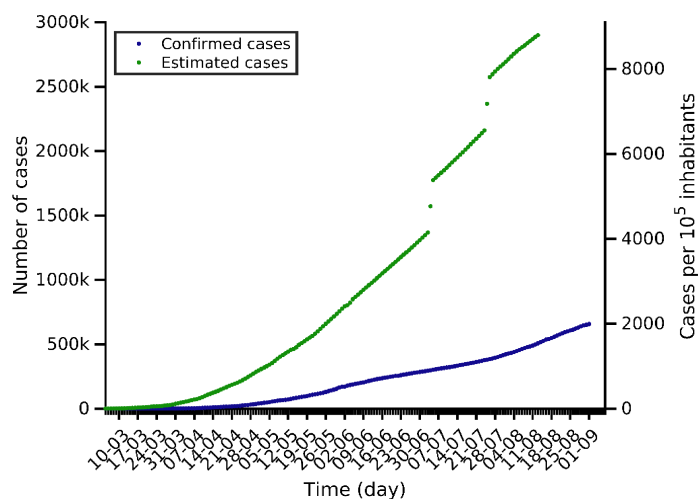
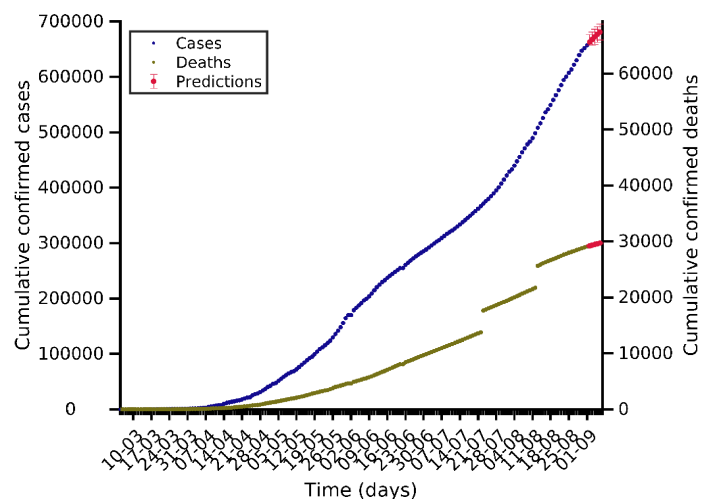
India 01-09-2020. Pop: 1353.0M. Cumulative incidence: 279/10⁵



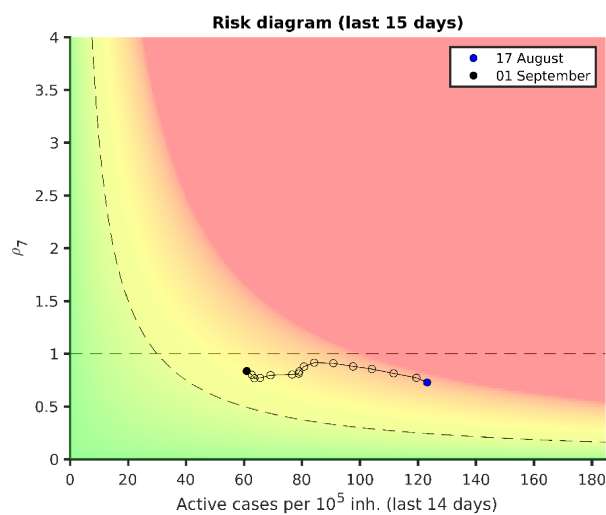
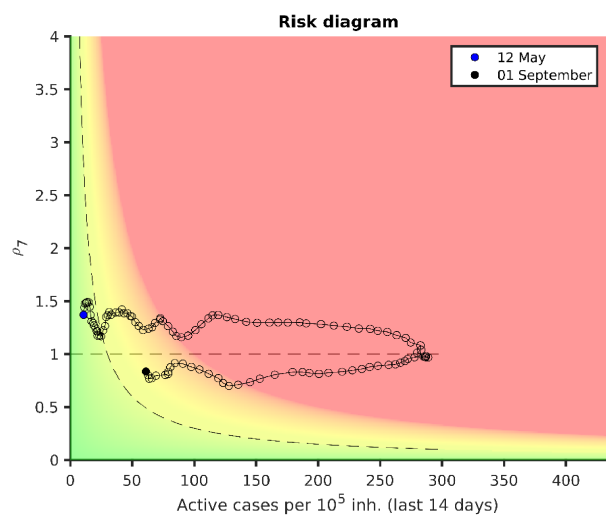
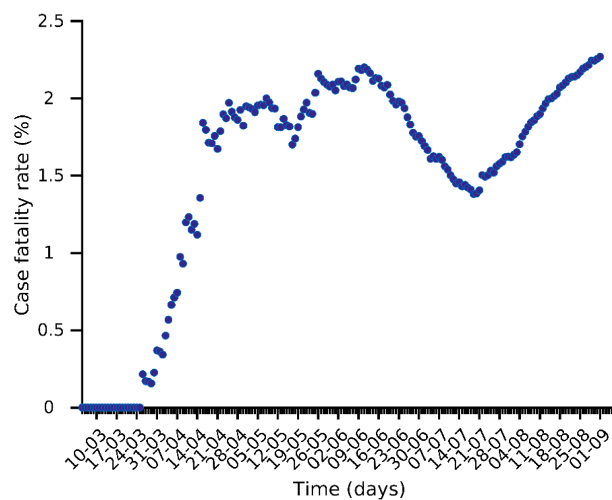
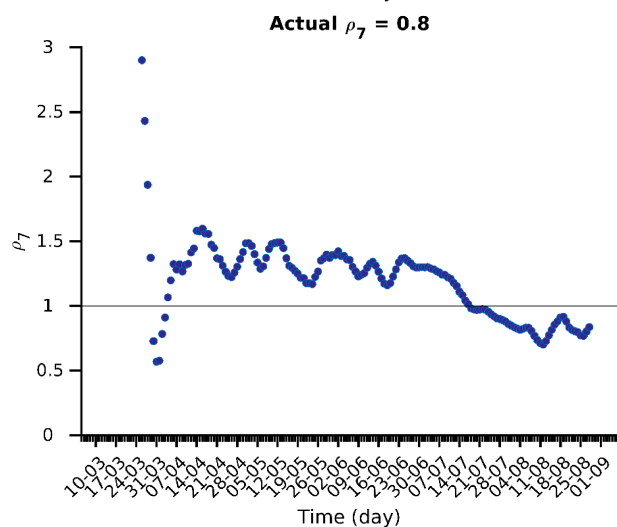
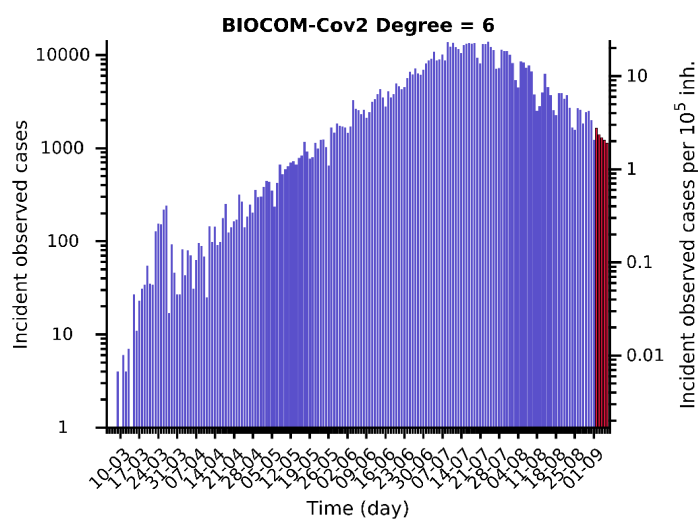
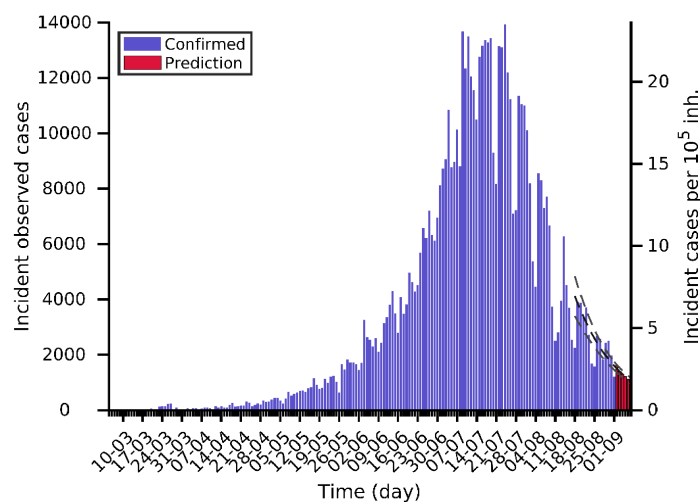
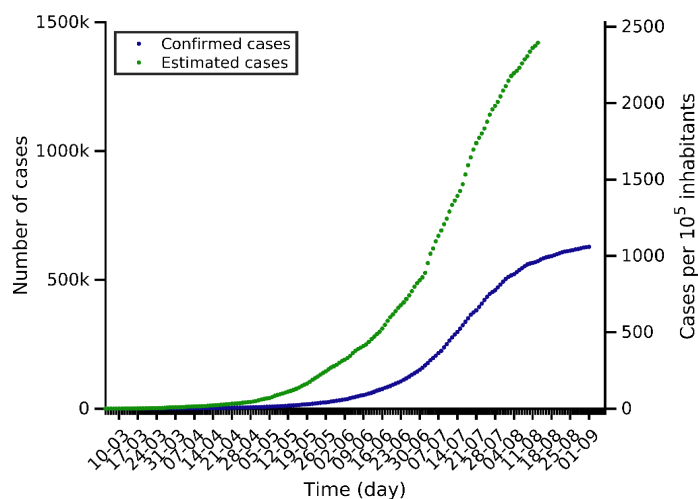
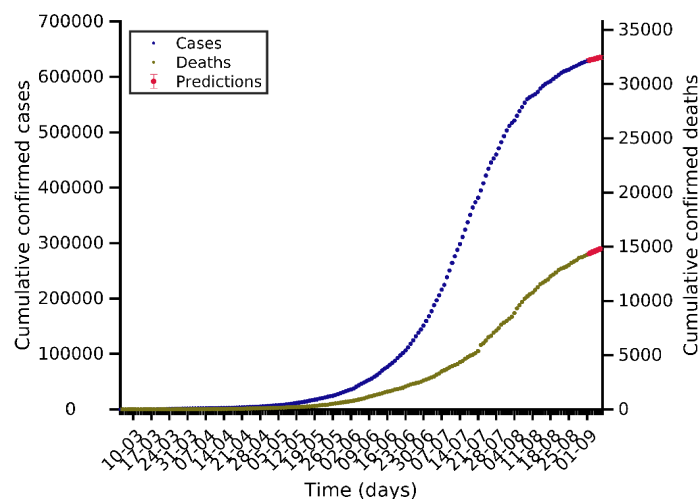
Russia 01-09-2020. Pop: 145.9M. Cumulative incidence: 685/10⁵



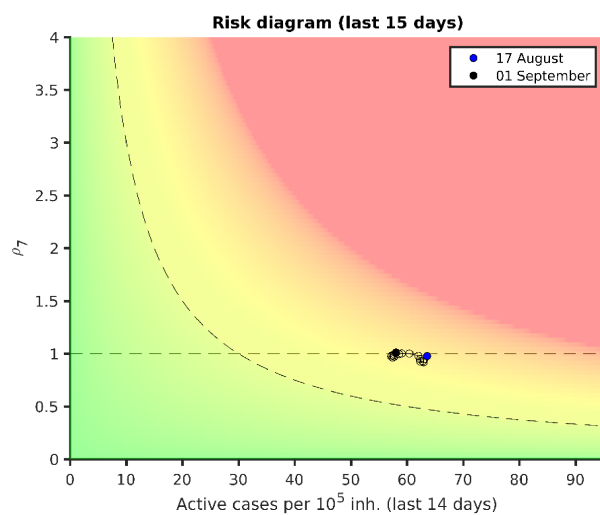
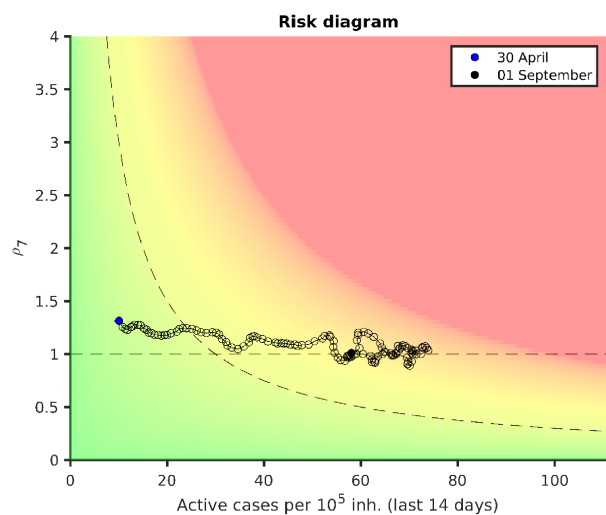
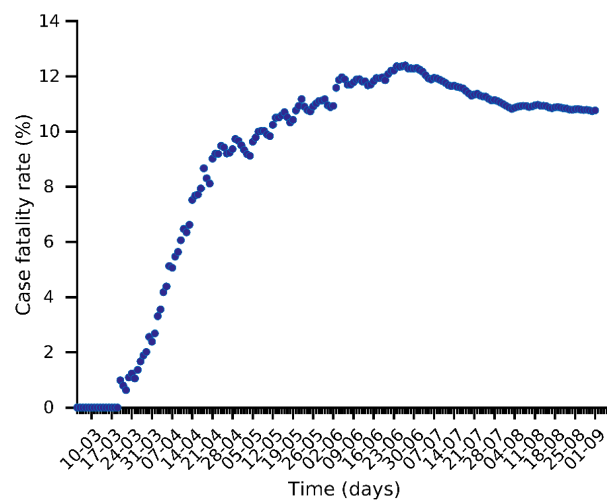
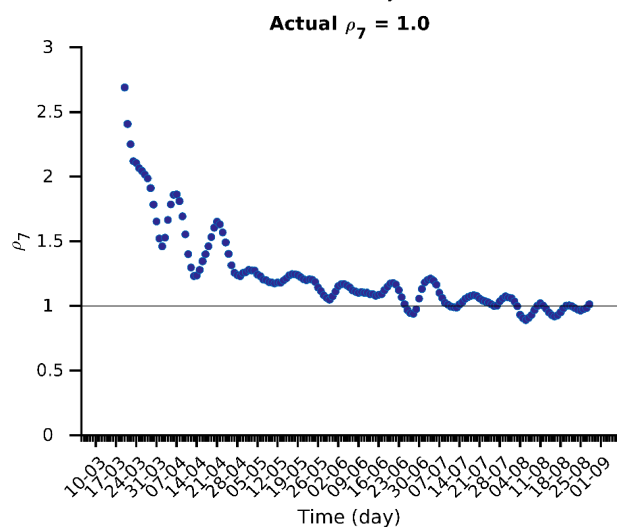
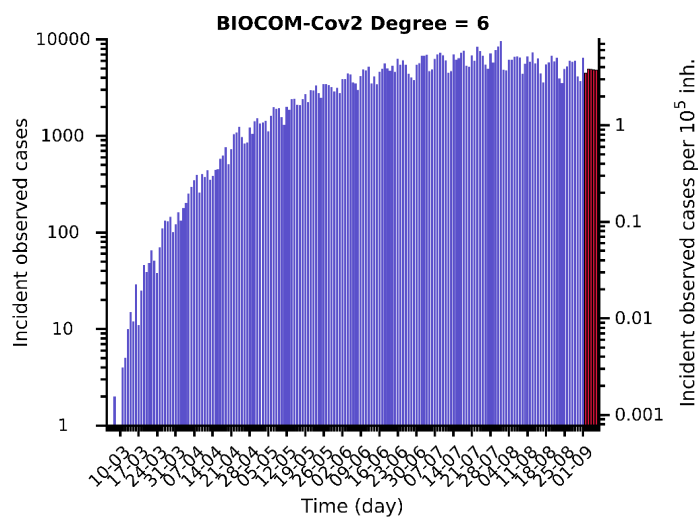
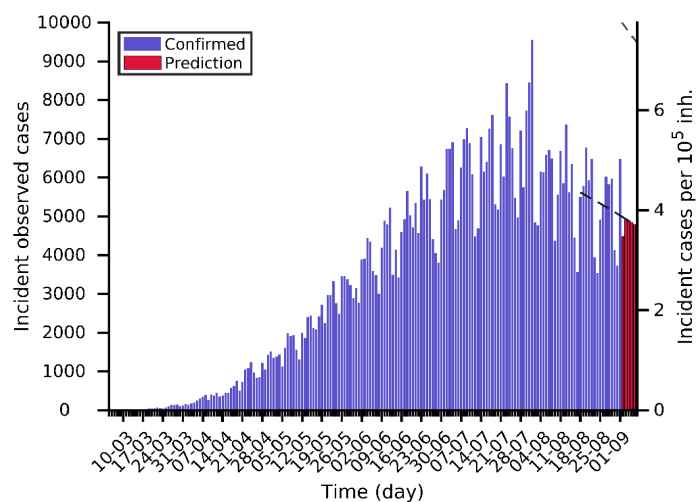
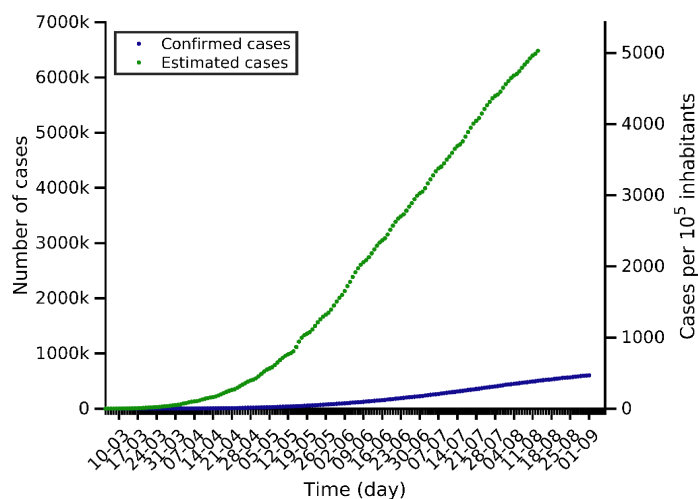
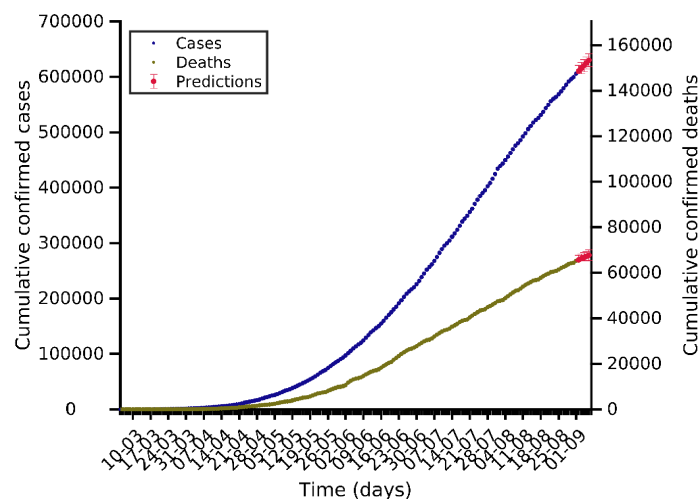
Peru 01-09-2020. Pop: 33.0M. Cumulative incidence: 1993/10⁵



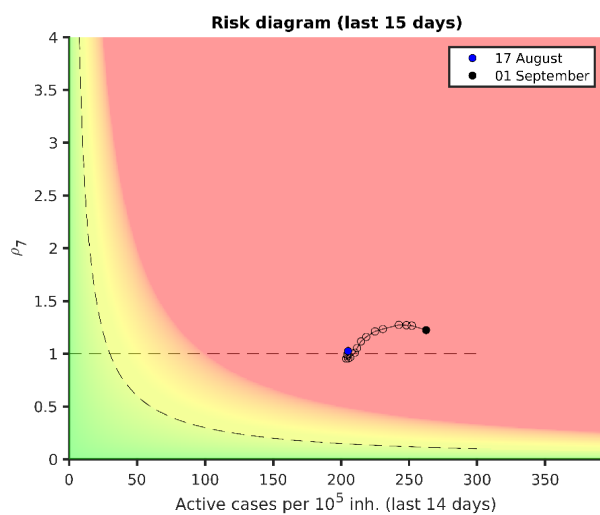
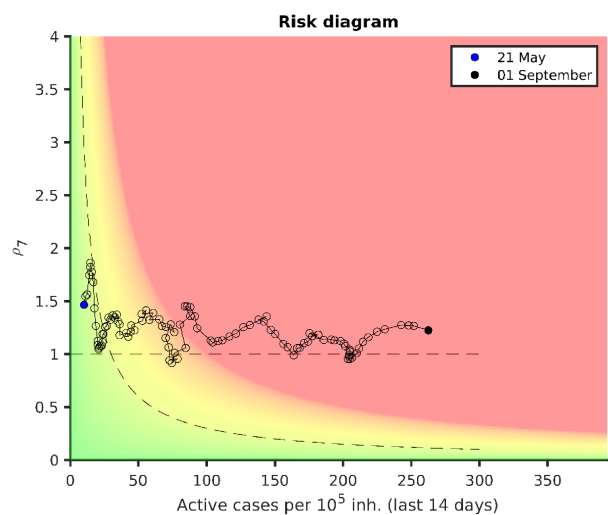
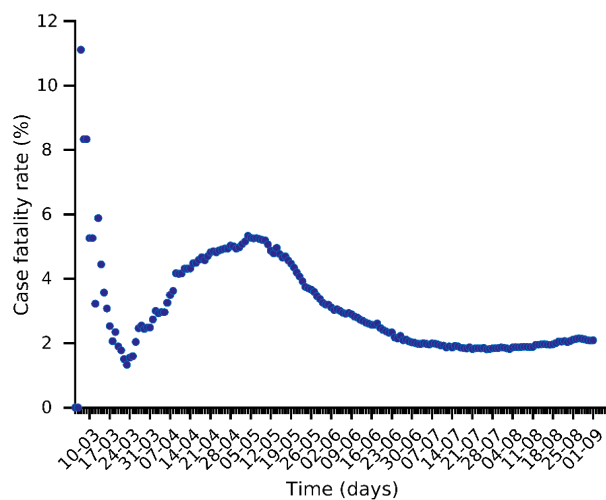
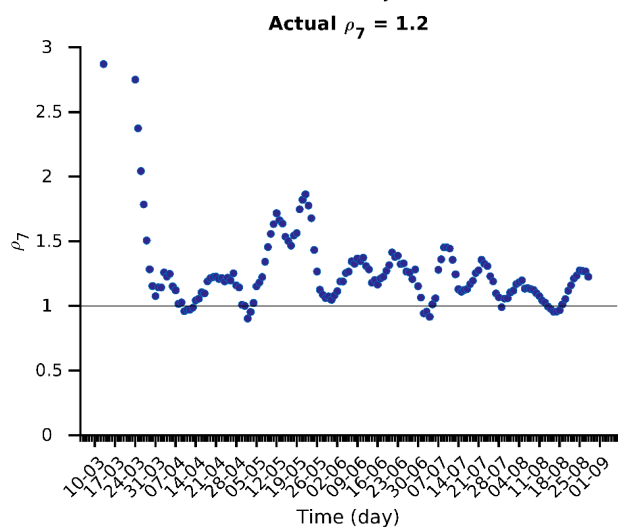
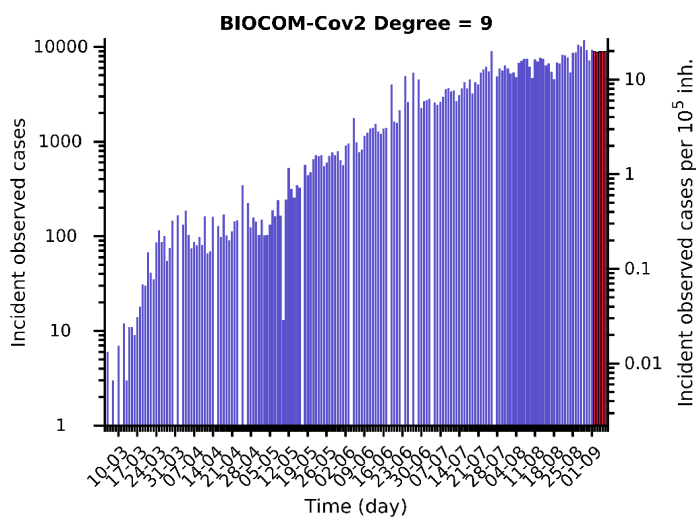
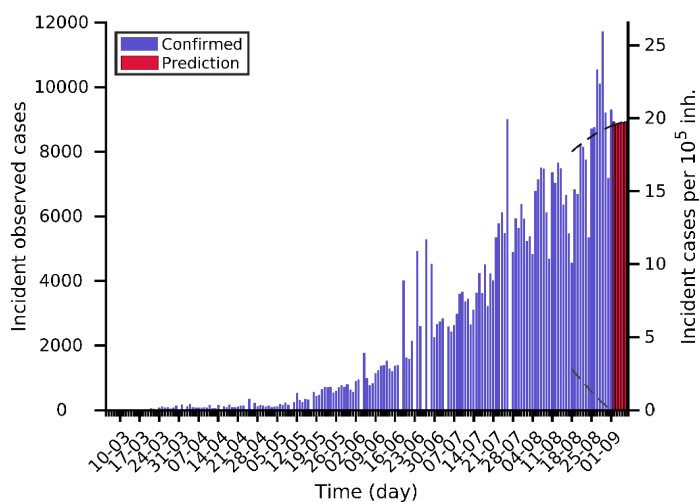
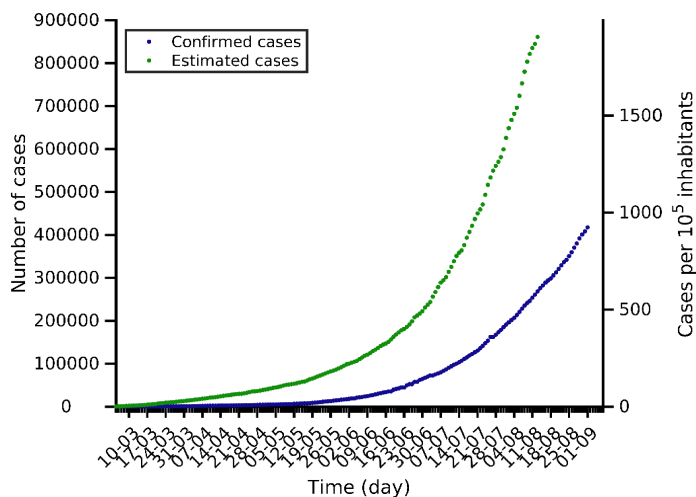
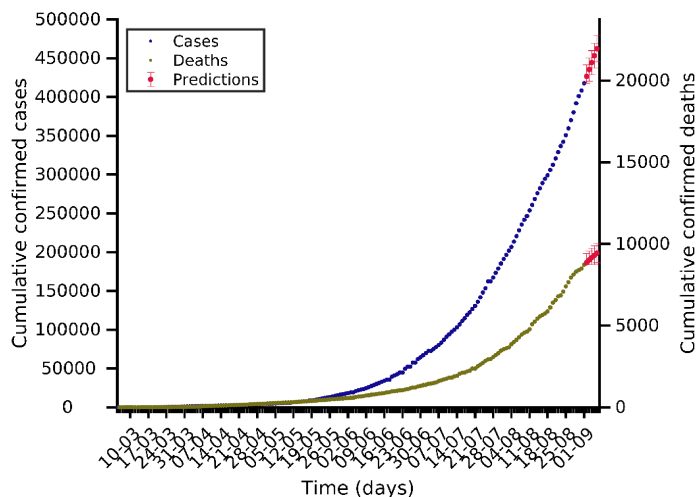
South Africa 01-09-2020. Pop: 59.3M. Cumulative incidence: 1059/10⁵



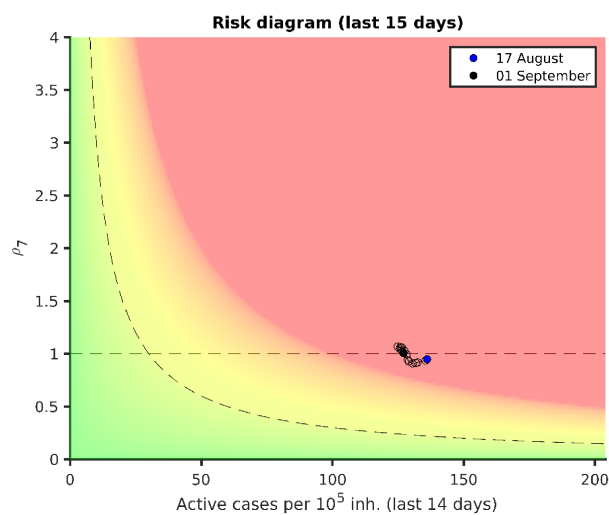
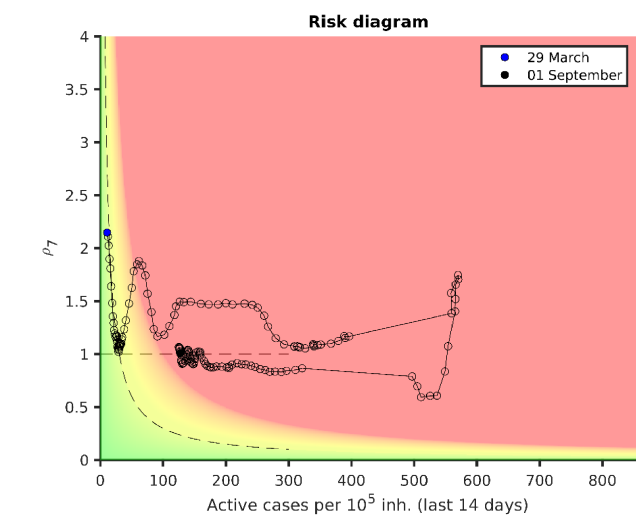
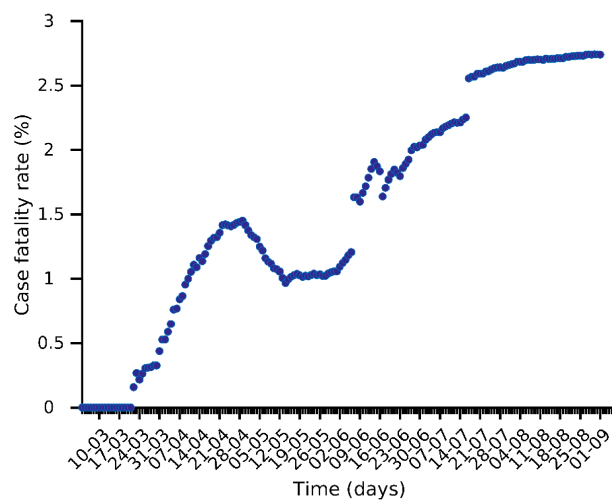
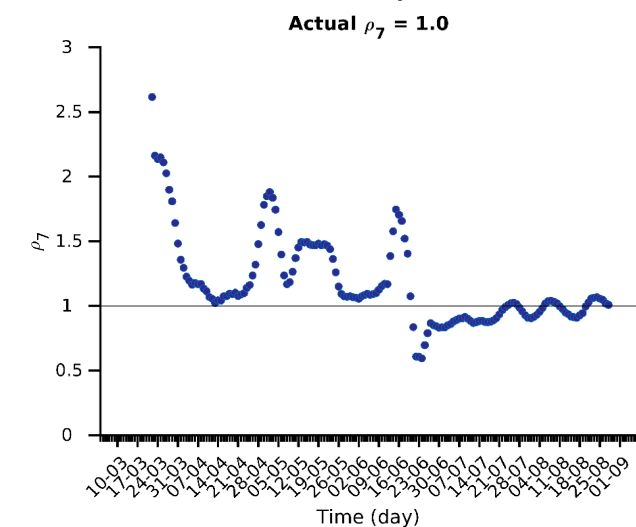
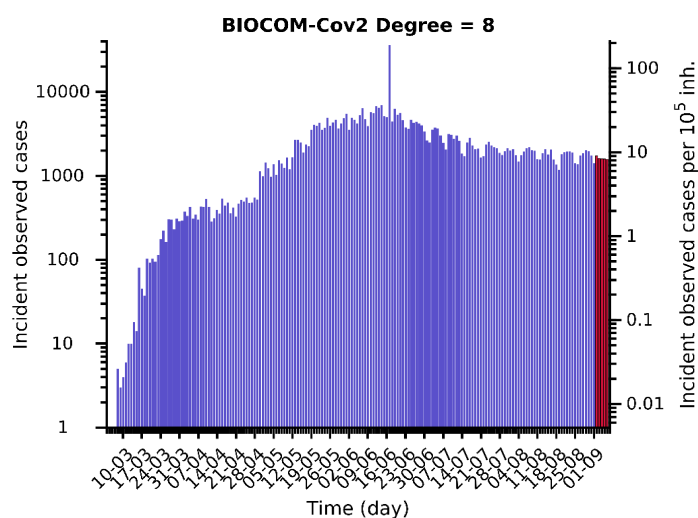
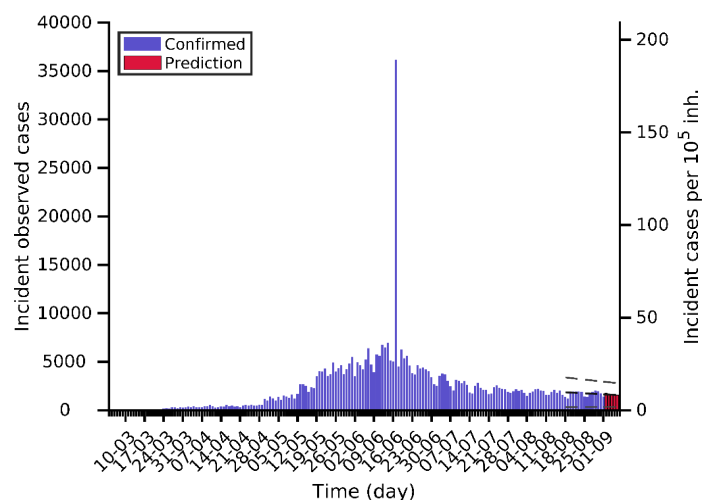
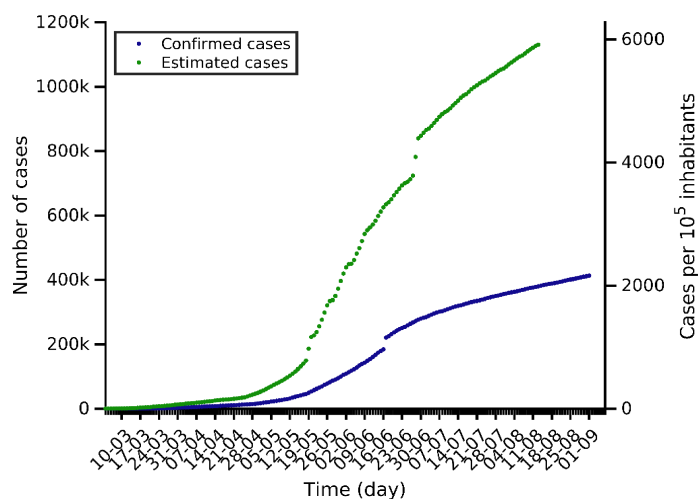
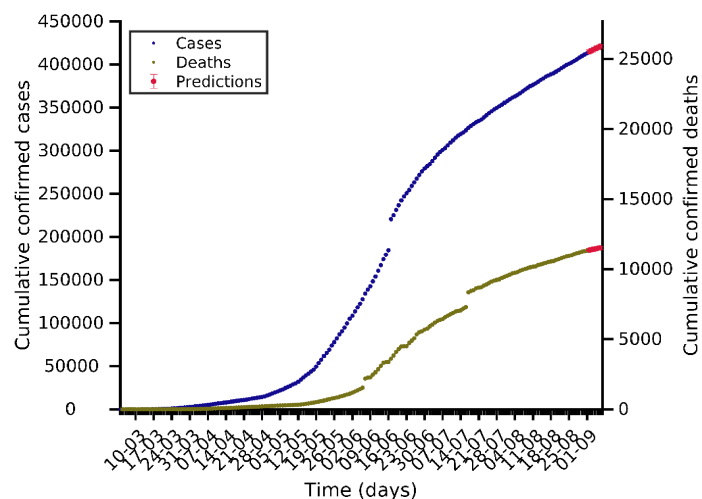
Mexico 01-09-2020. Pop: 128.9M. Cumulative incidence: 470/10⁵



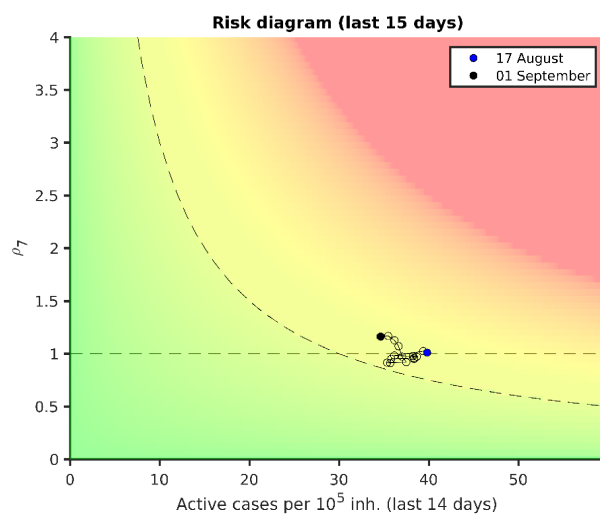
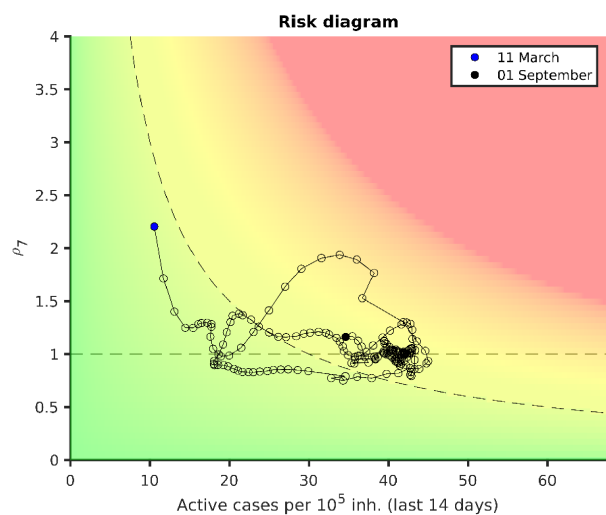
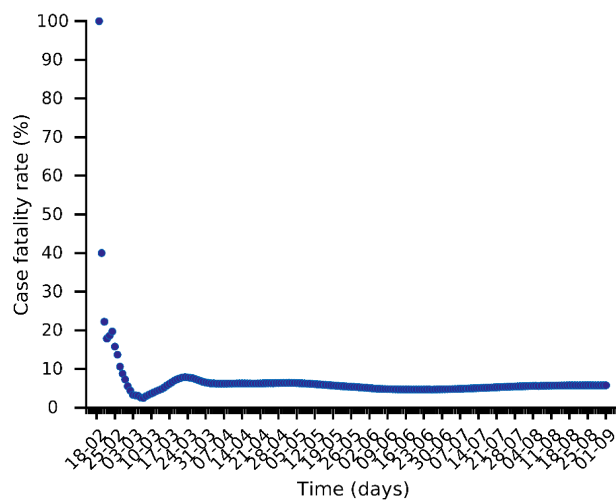
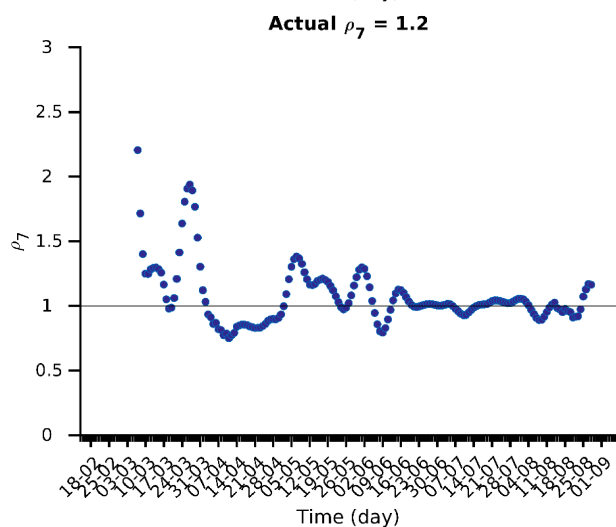
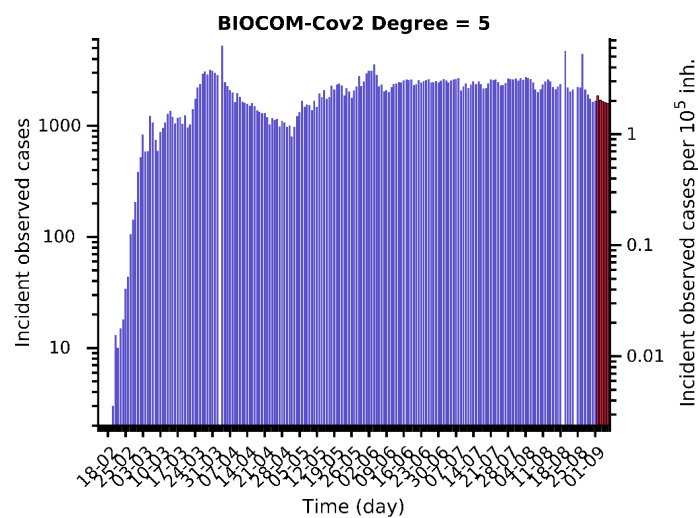
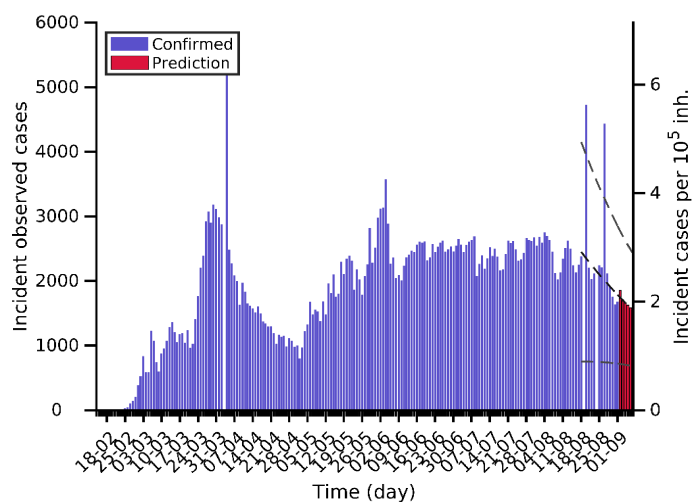
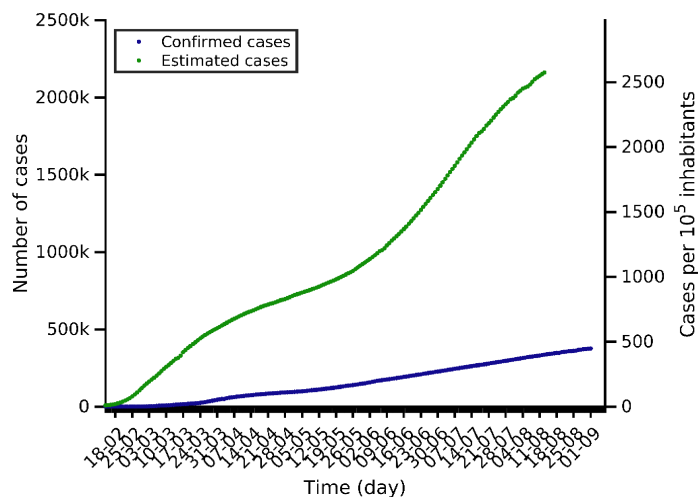
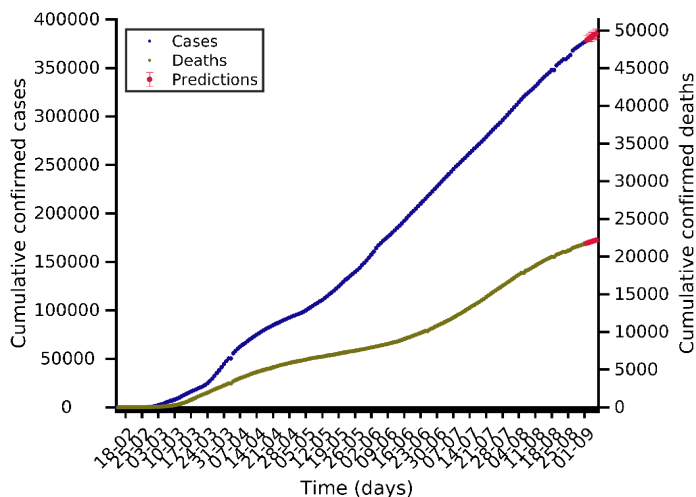
Argentina 01-09-2020. Pop: 45.2M. Cumulative incidence: 924/10⁵



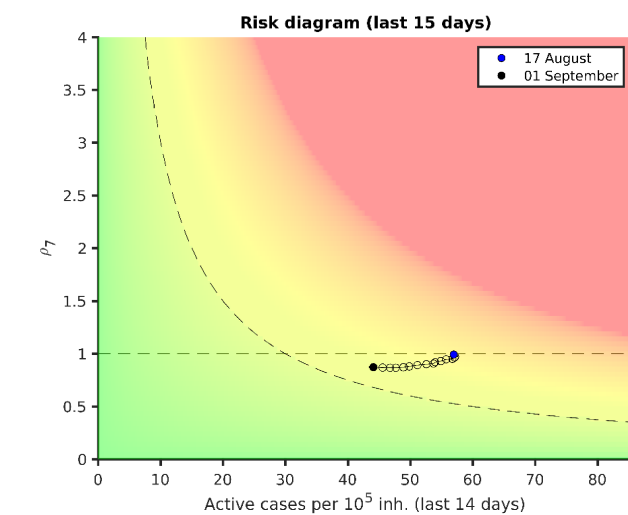
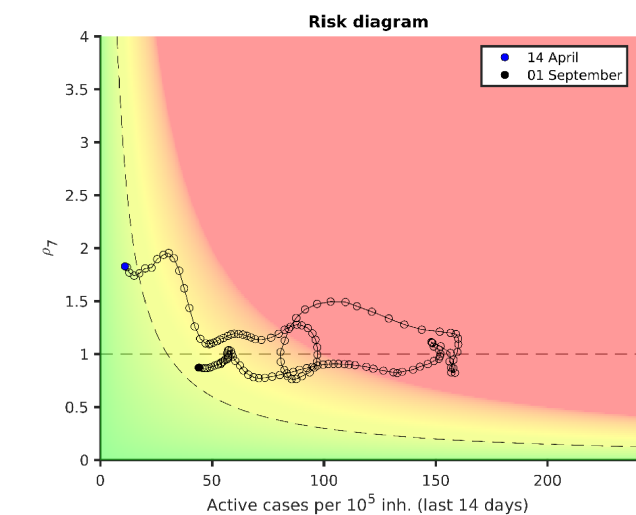
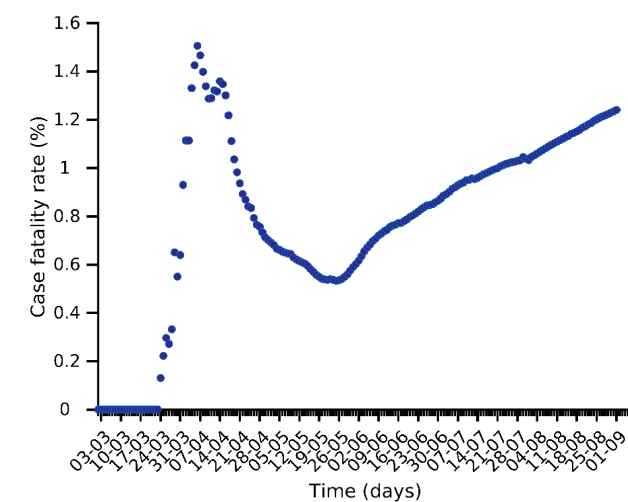
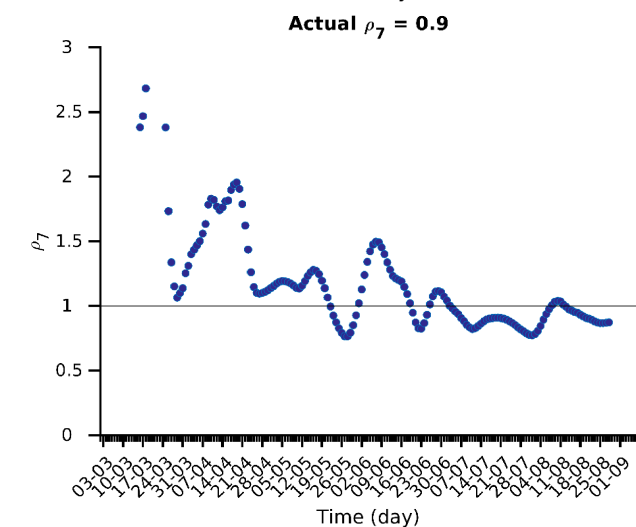
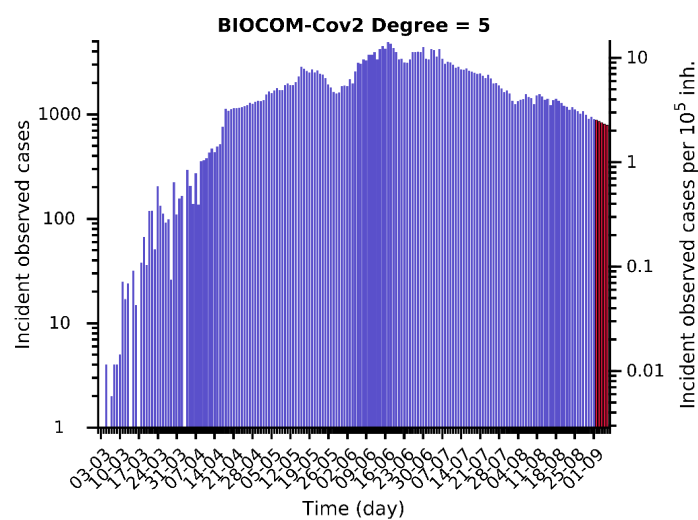
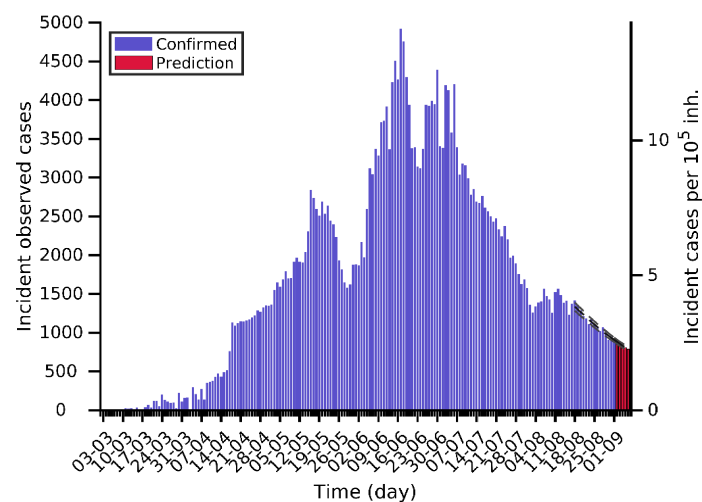
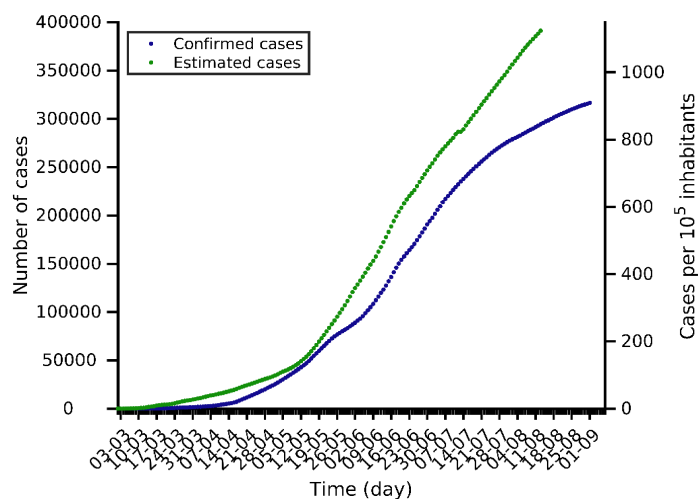
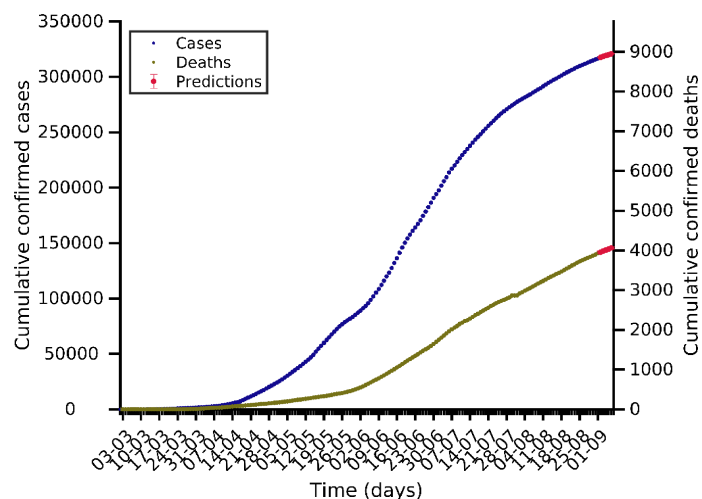
Chile 01-09-2020. Pop: 19.1M. Cumulative incidence: 2161/10⁵



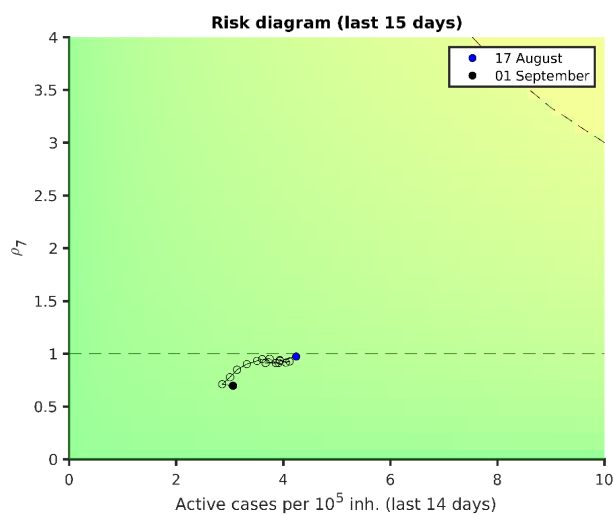
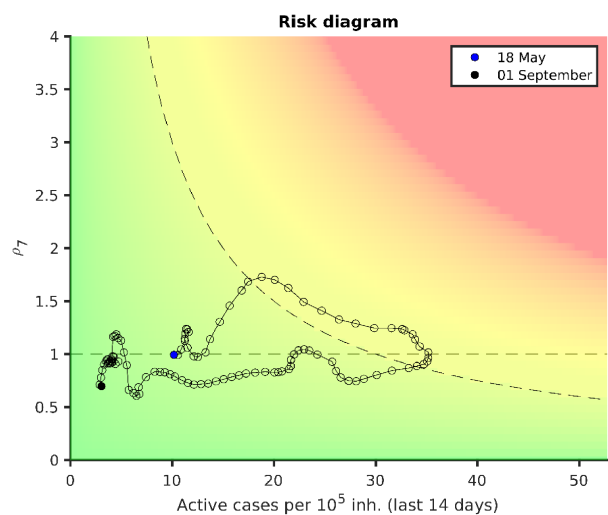
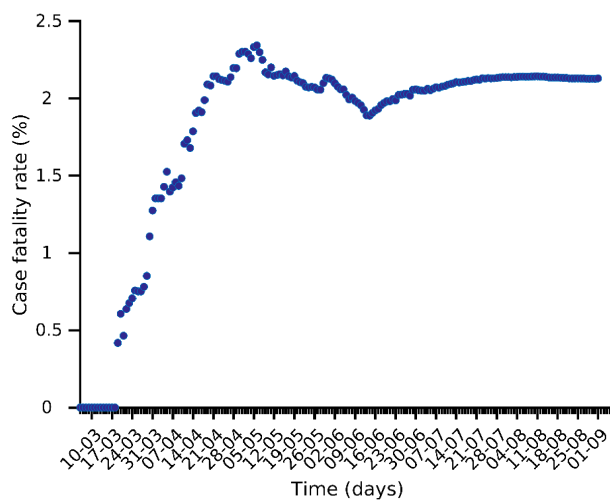
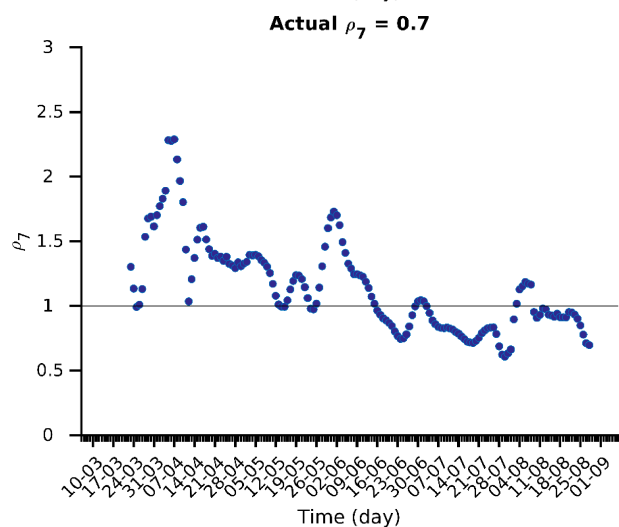
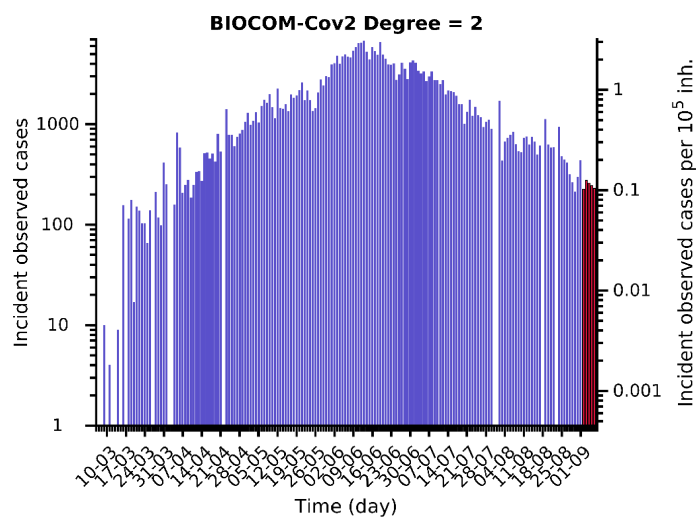
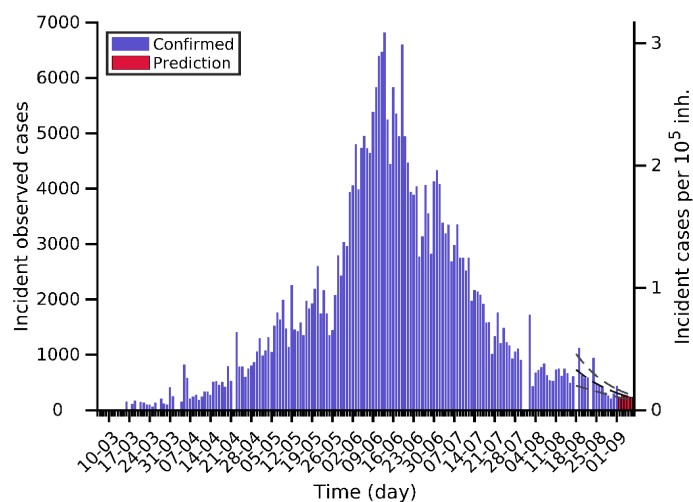
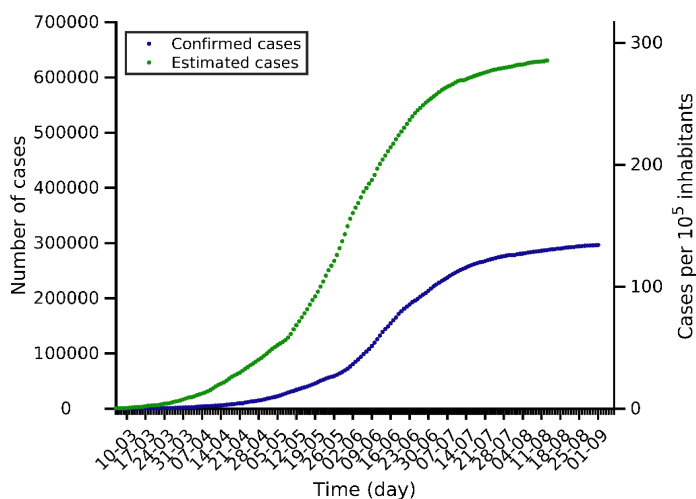
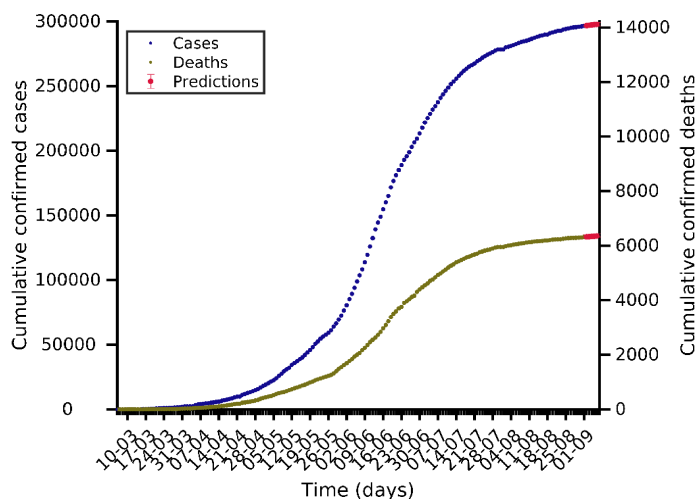
Iran 01-09-2020. Pop: 84.0M. Cumulative incidence: 449/10⁵



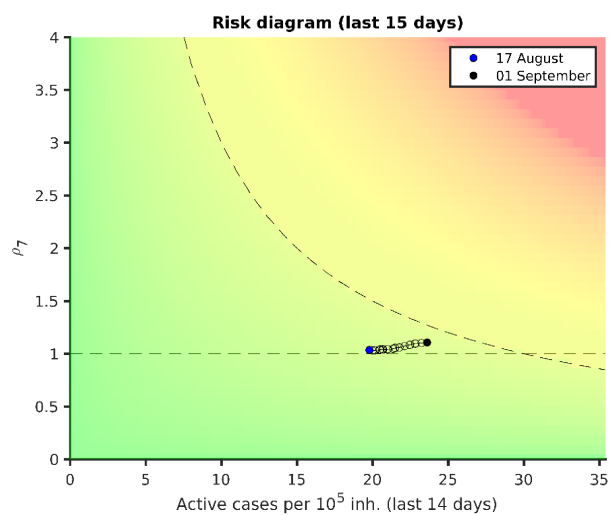
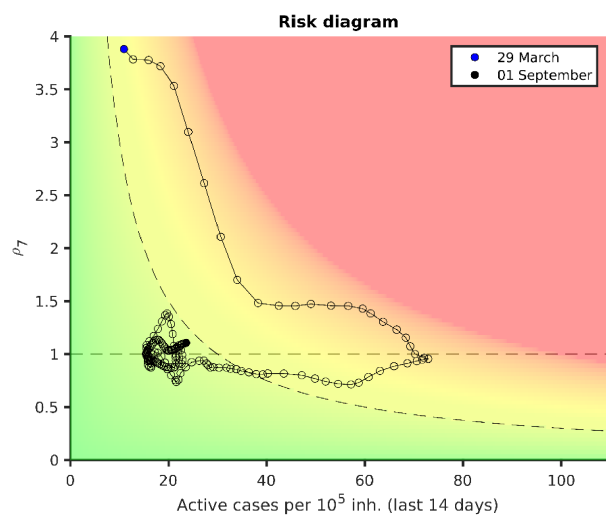
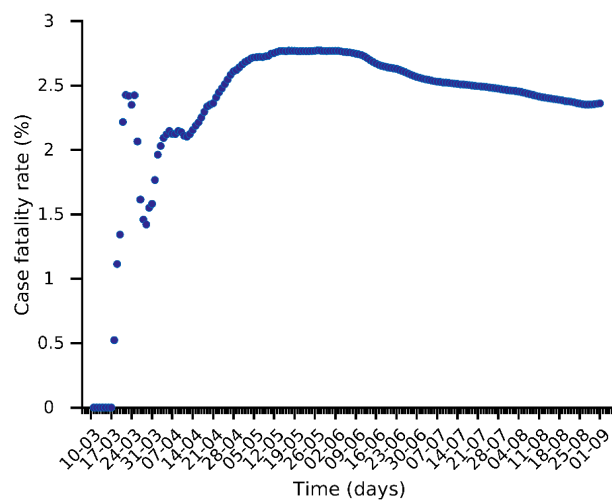
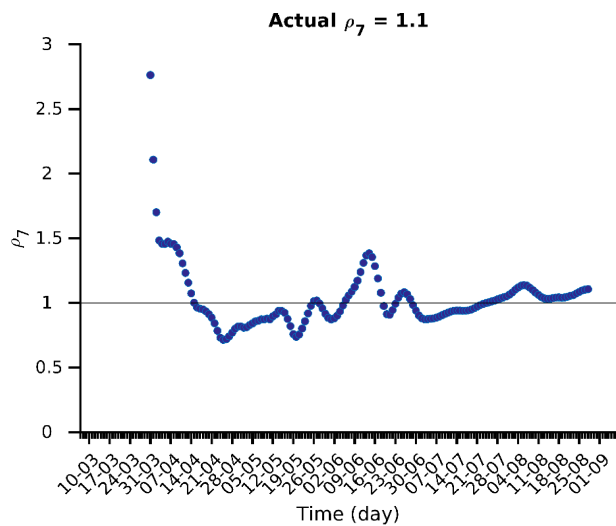
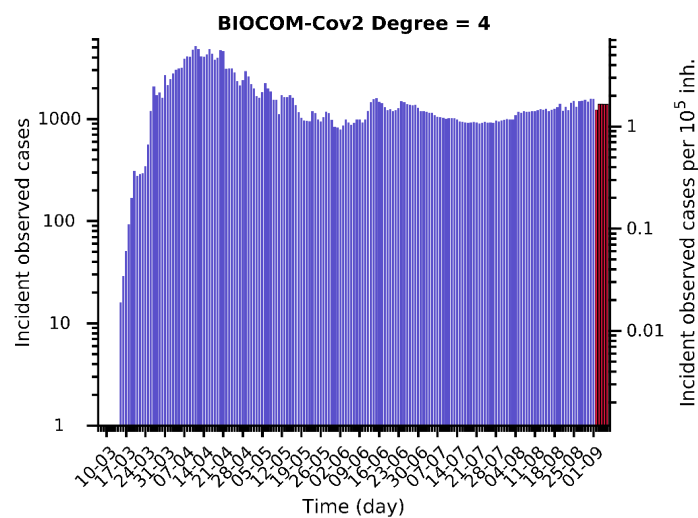
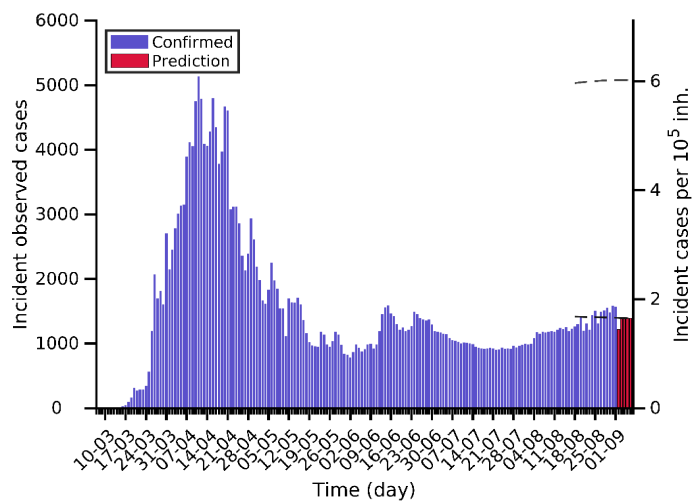
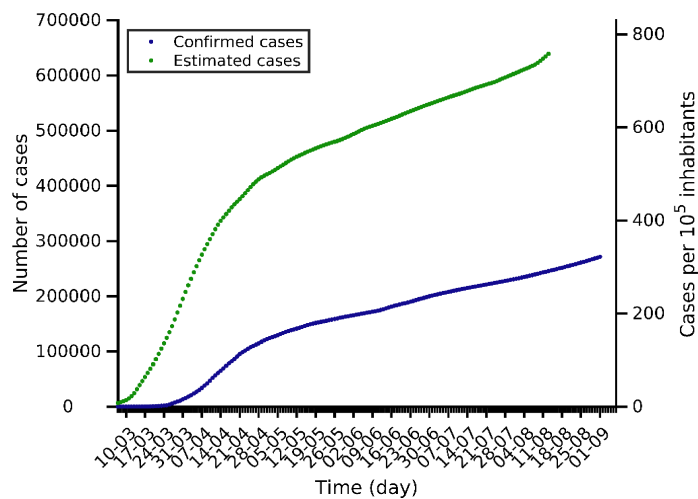
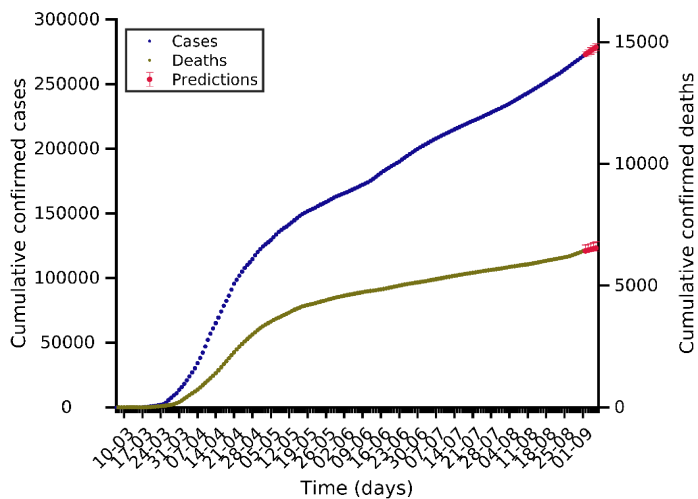
Saudi Arabia 01-09-2020. Pop: 34.8M. Cumulative incidence: 910/10⁵



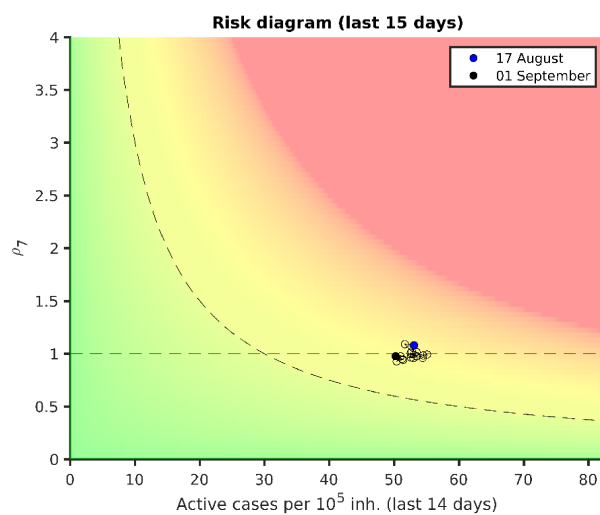
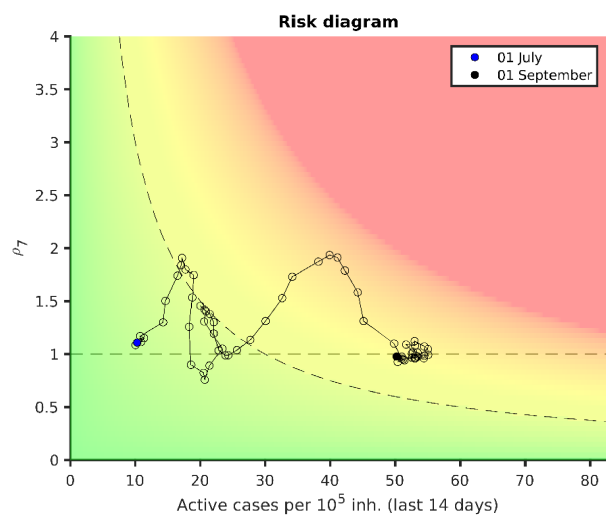
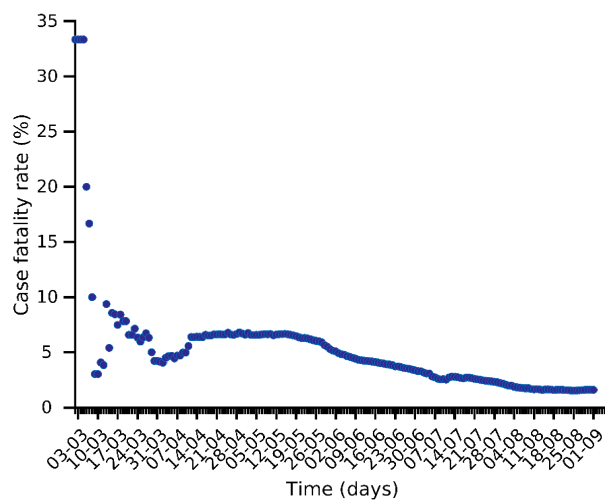
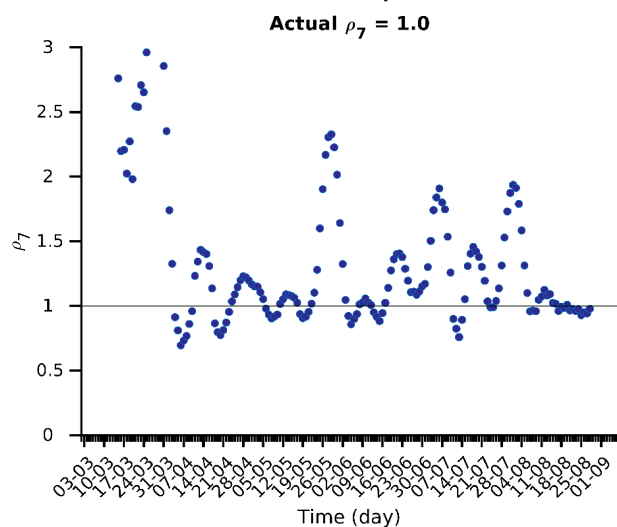
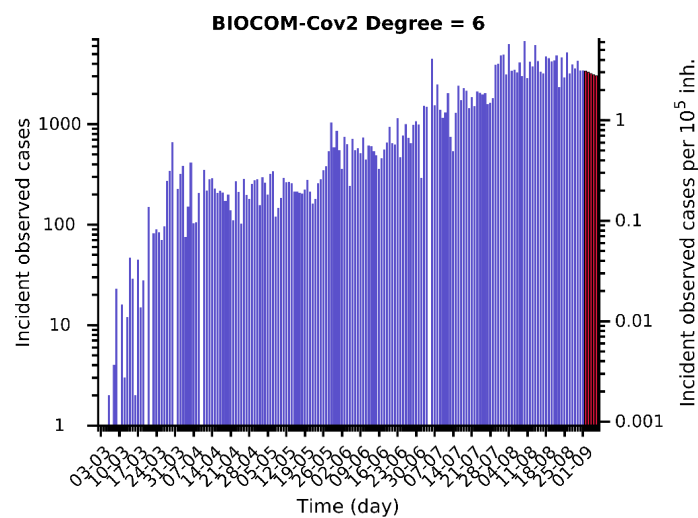
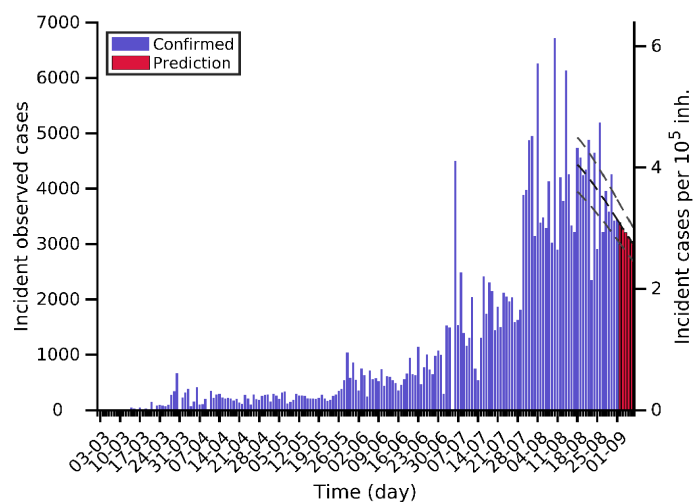
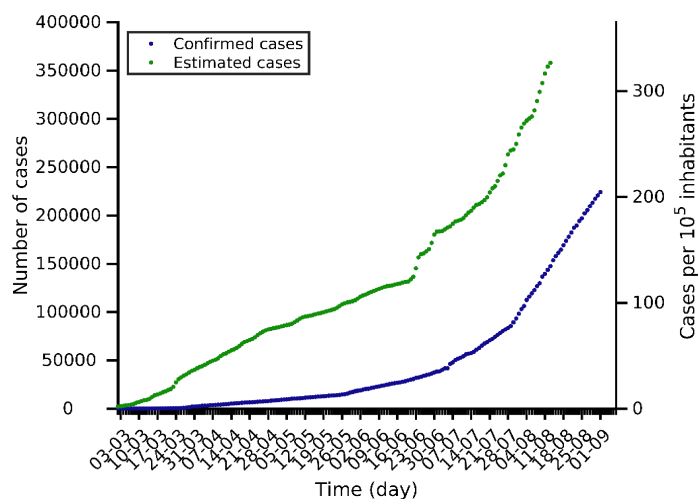
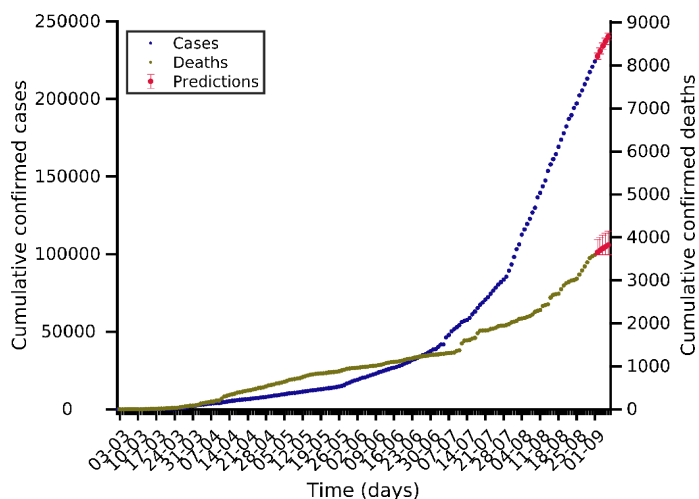
Pakistan 01-09-2020. Pop: 220.9M. Cumulative incidence: 134/10⁵



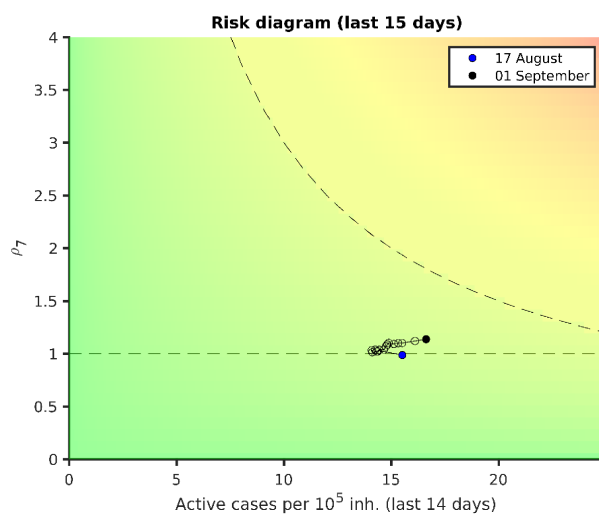
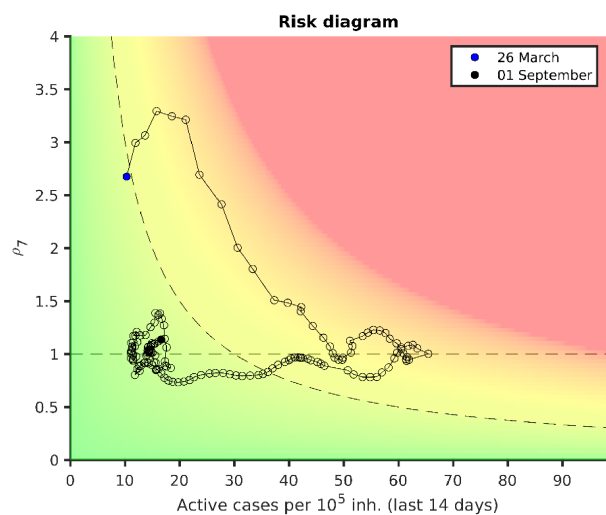
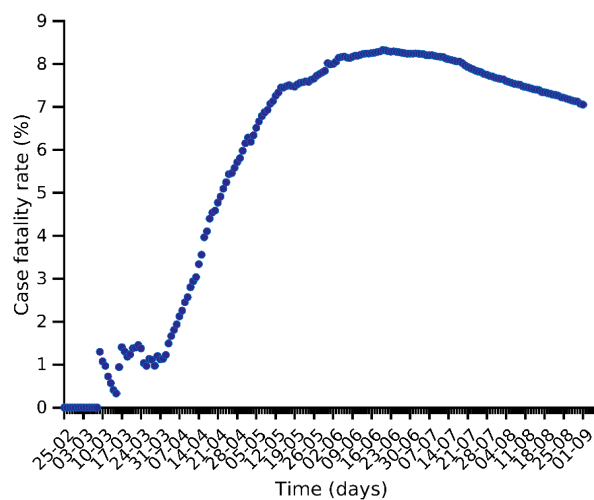
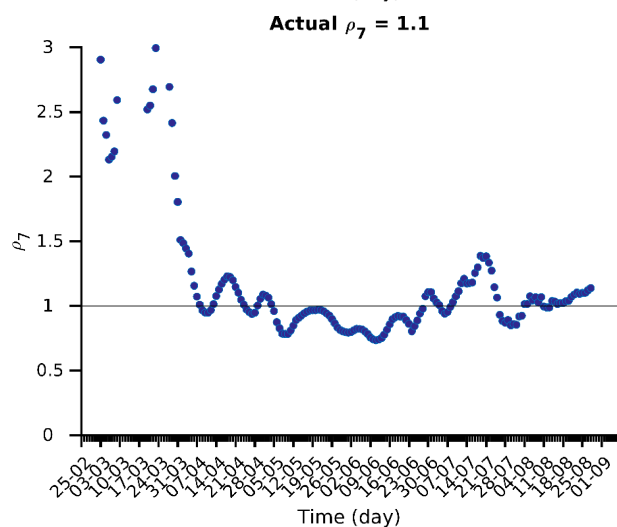
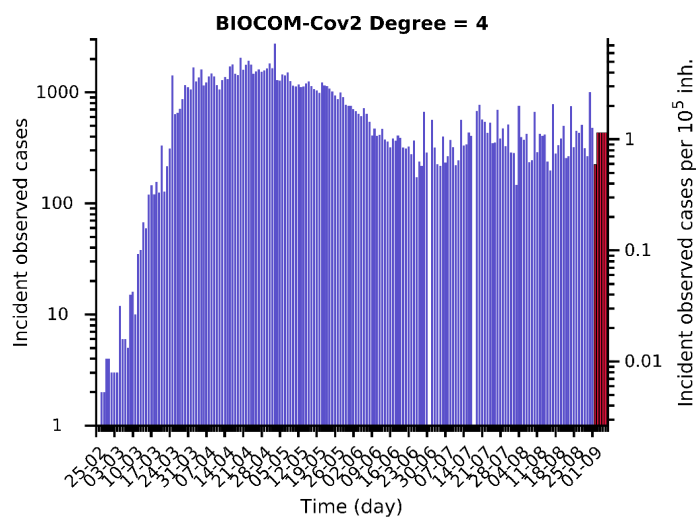
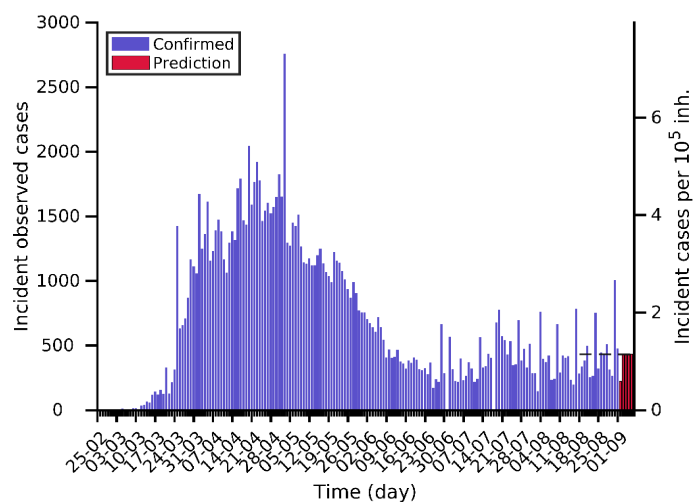
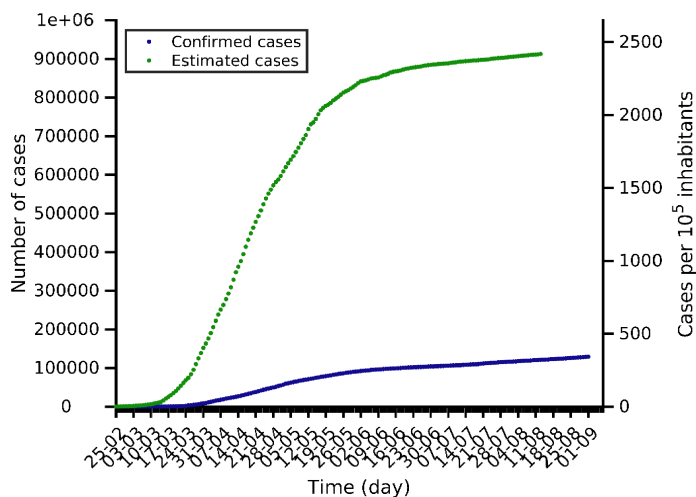
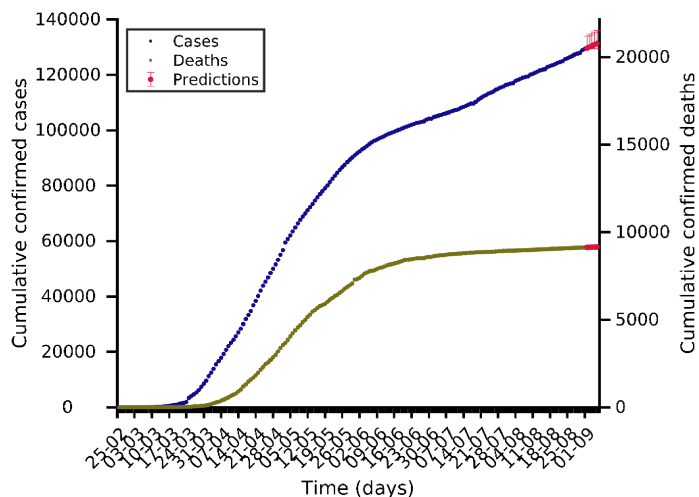
Turkey 01-09-2020. Pop: 84.3M. Cumulative incidence: 322/10⁵



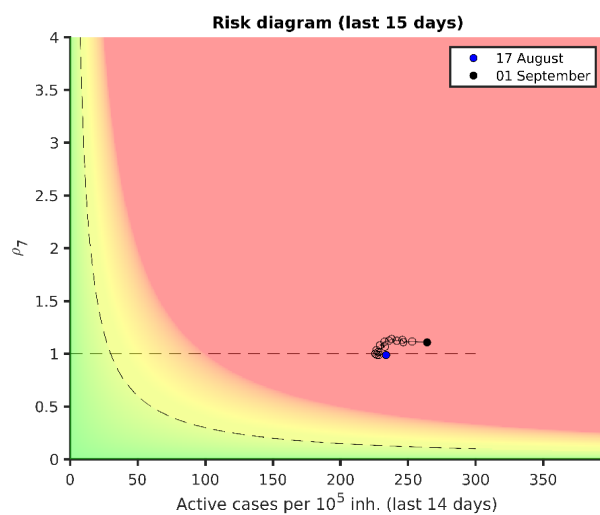
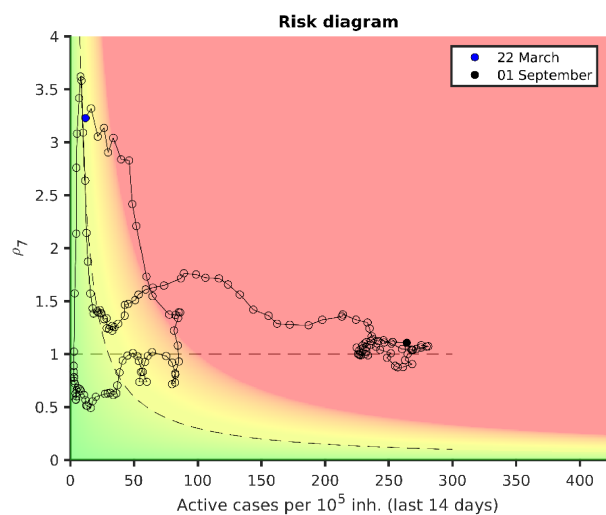
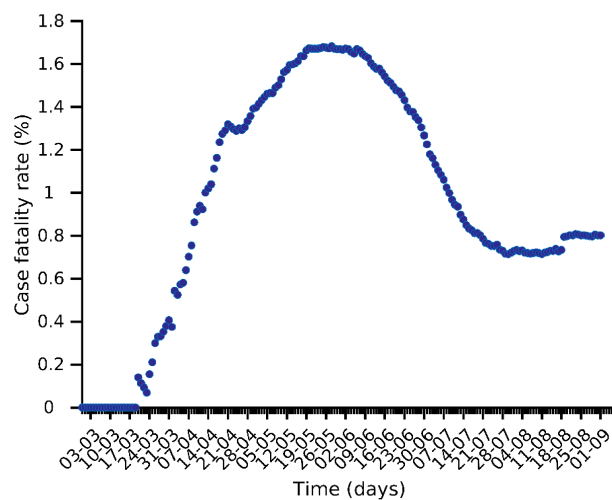
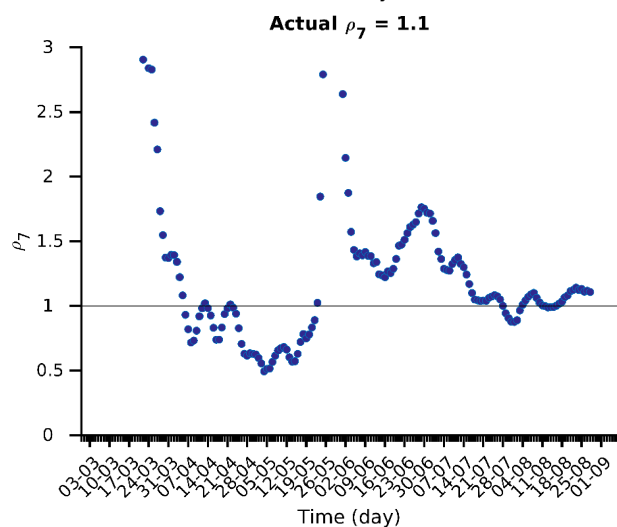
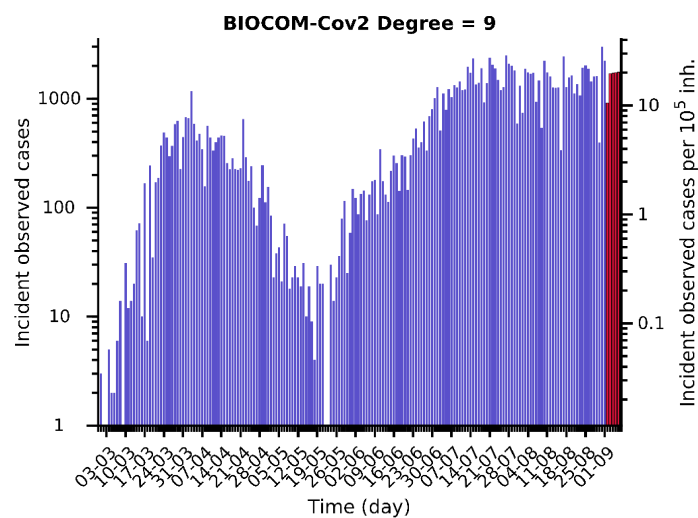
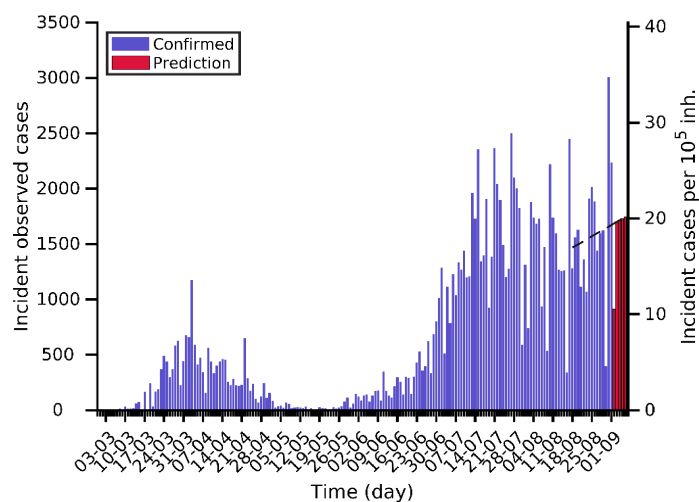
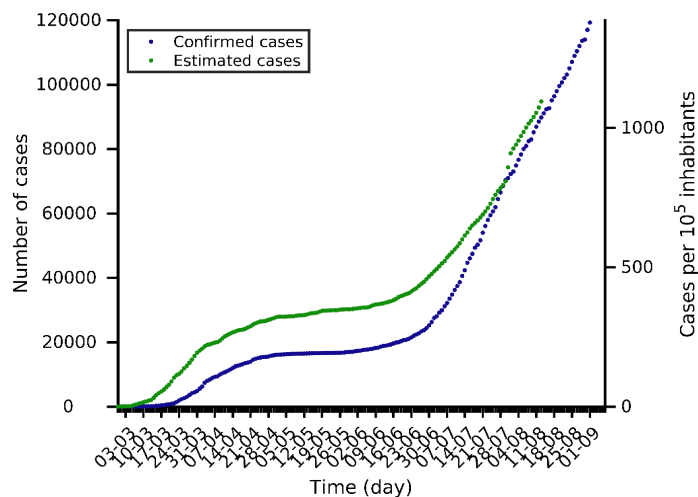
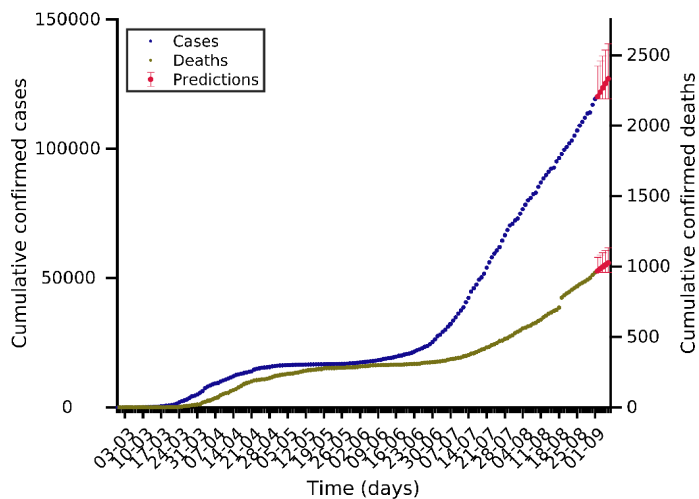
Philippines 01-09-2020. Pop: 109.6M. Cumulative incidence: 205/10⁵



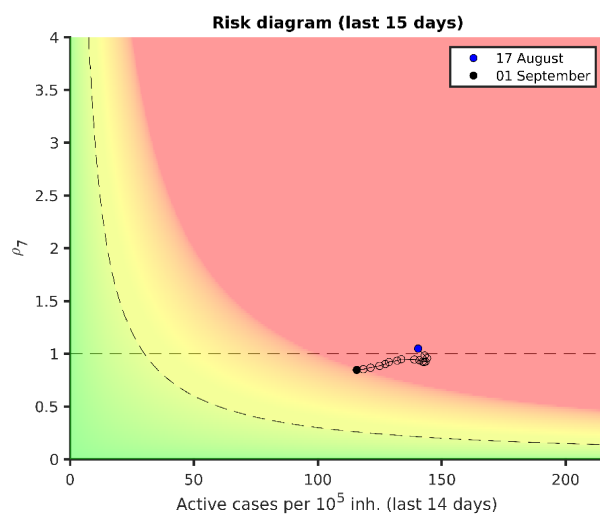
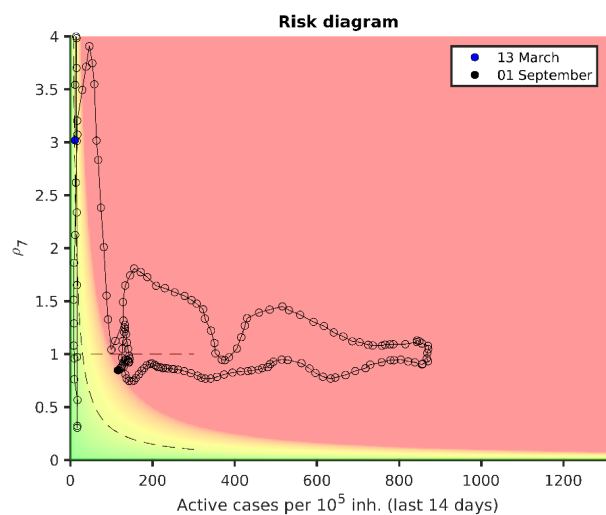
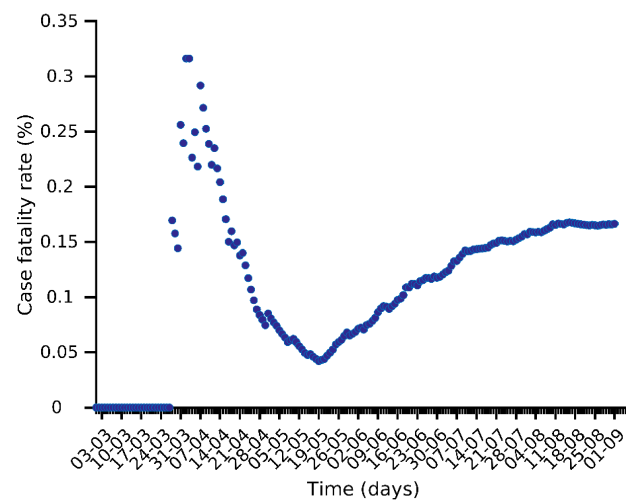
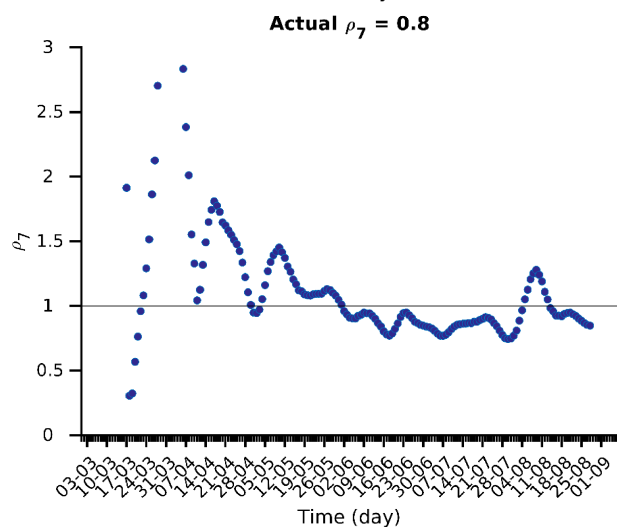
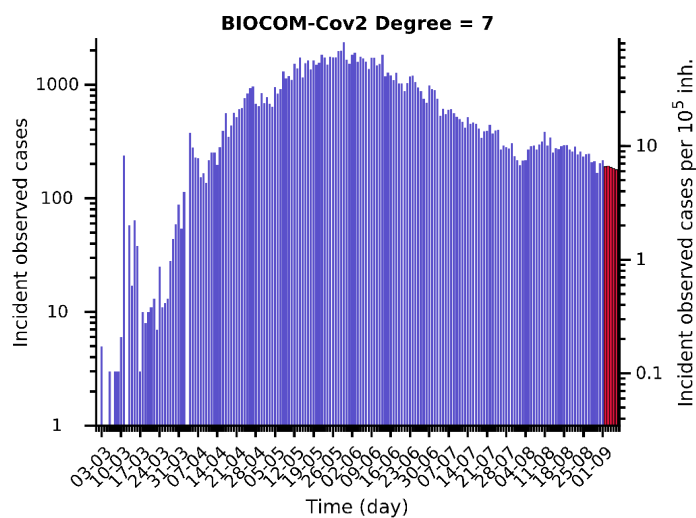
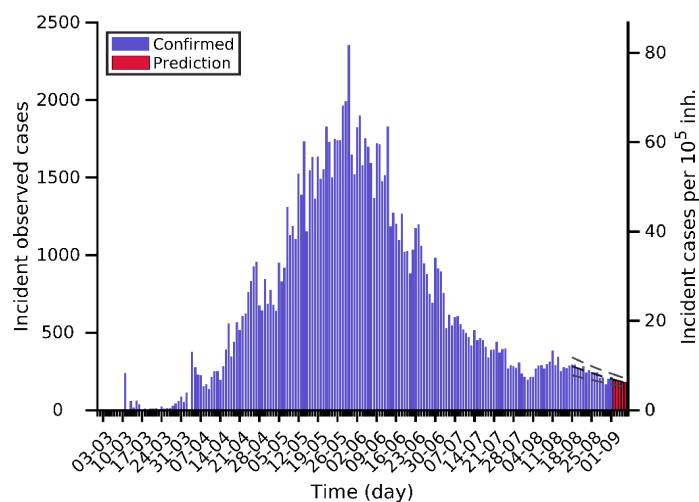
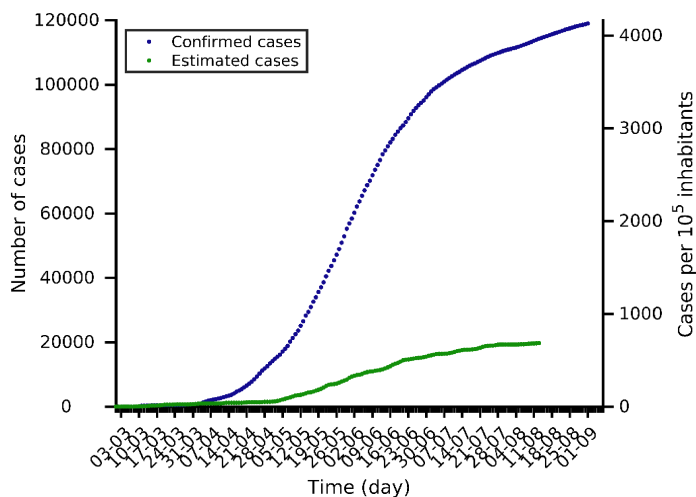
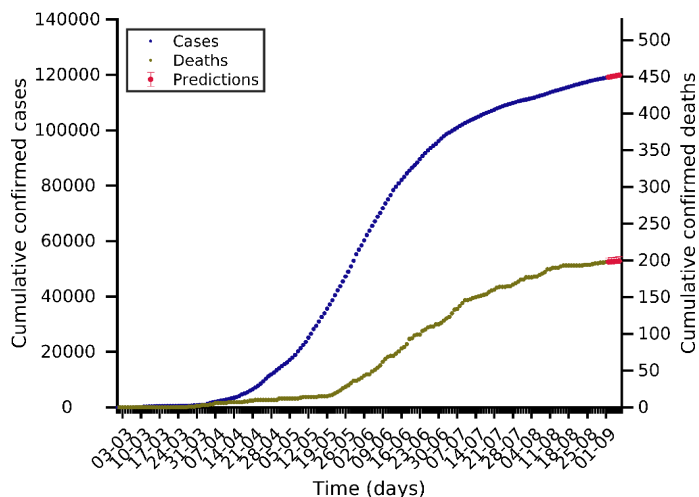
Canada 01-09-2020. Pop: 37.7M. Cumulative incidence: 343/10⁵



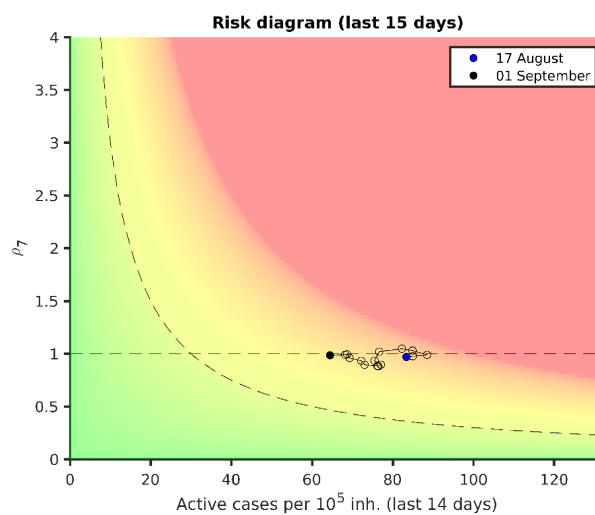
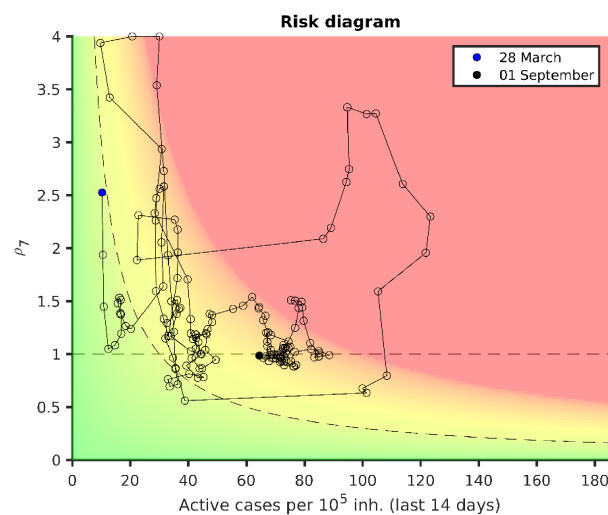
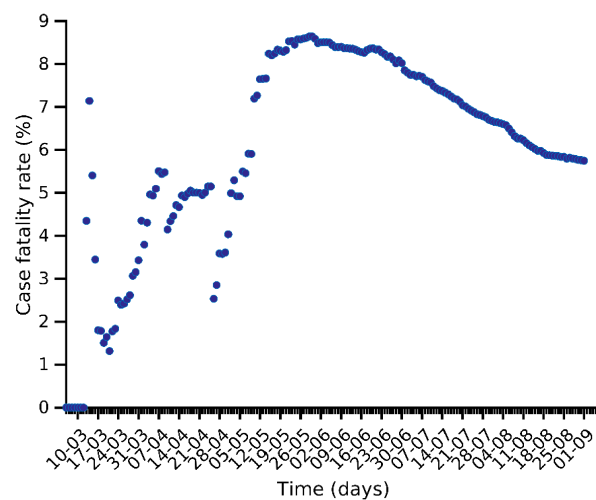
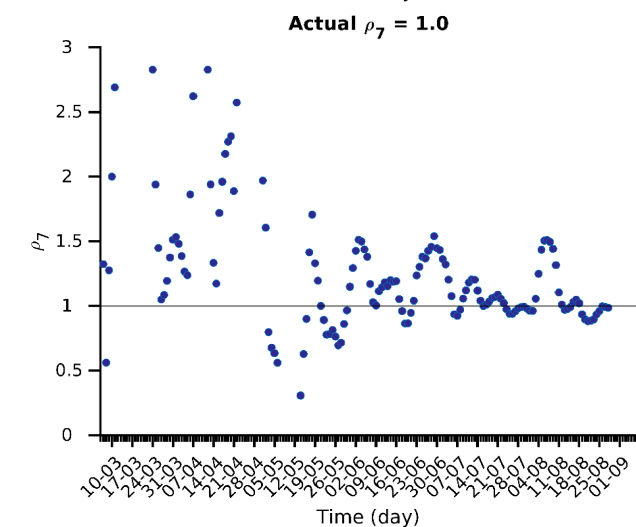
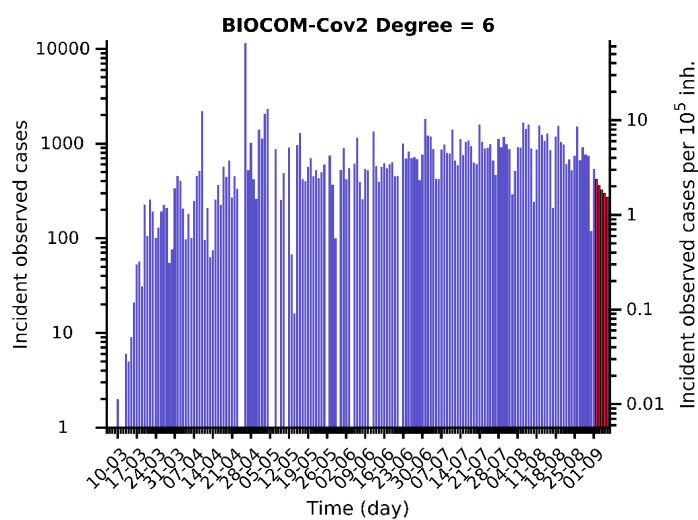
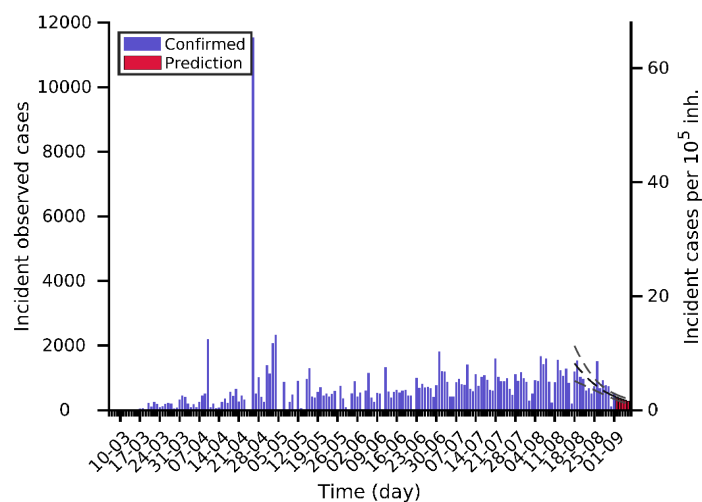
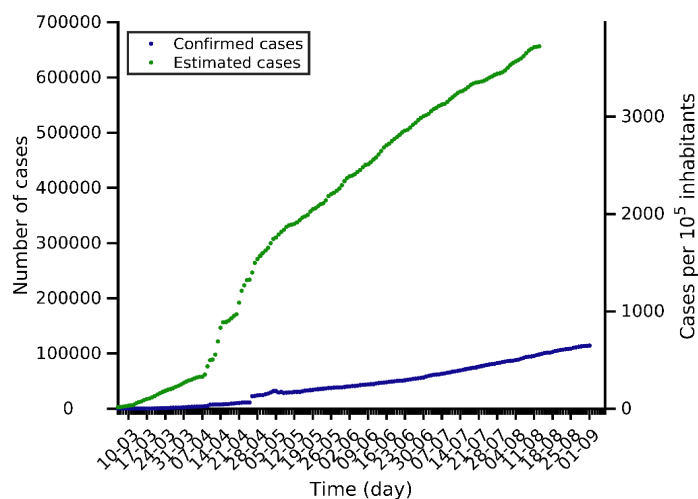
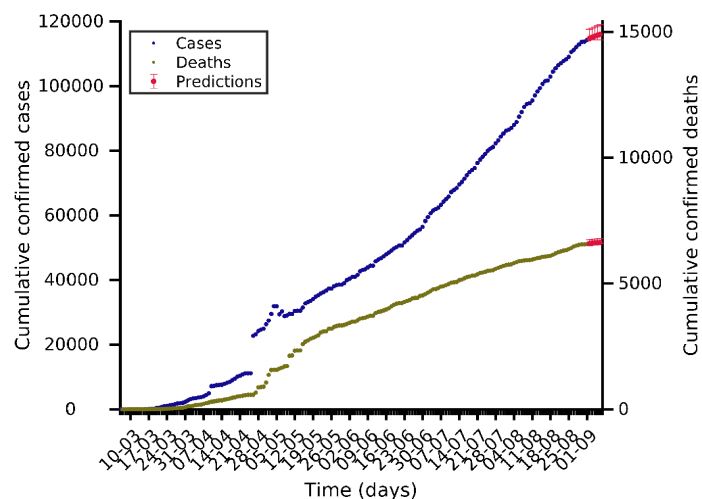
Israel 01-09-2020. Pop: 8.7M. Cumulative incidence: 1378/10⁵



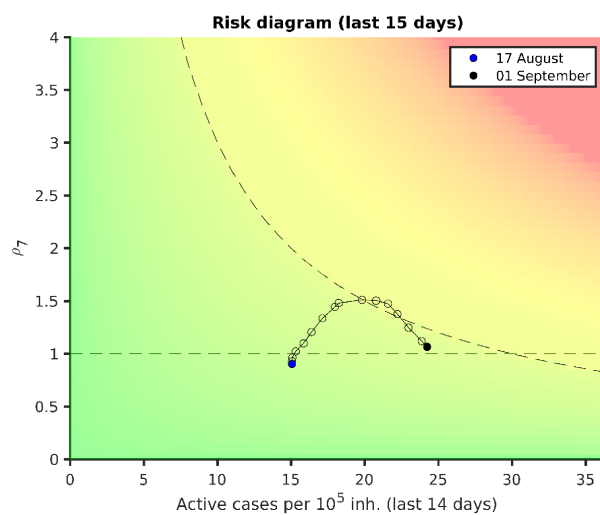
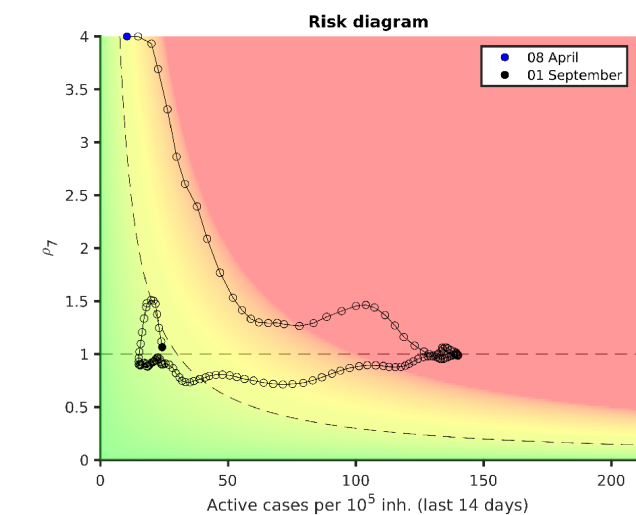
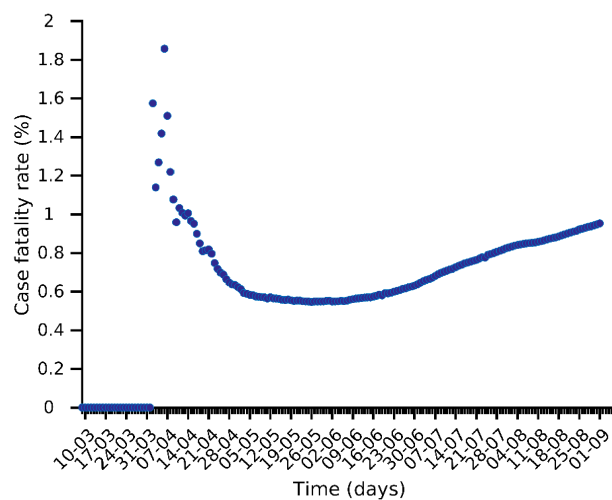
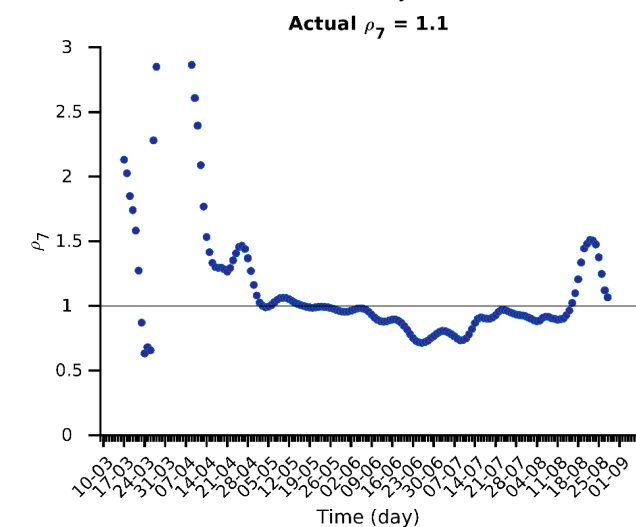
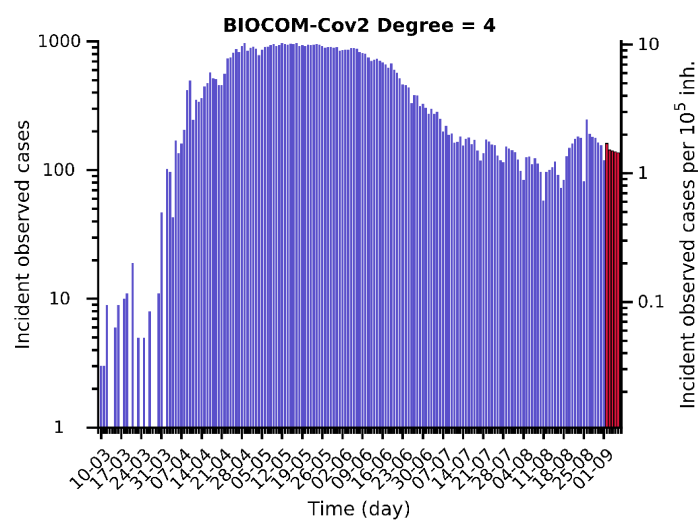
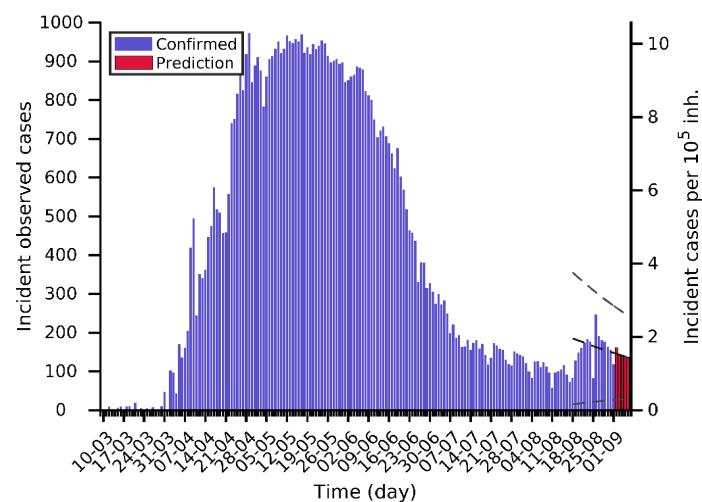
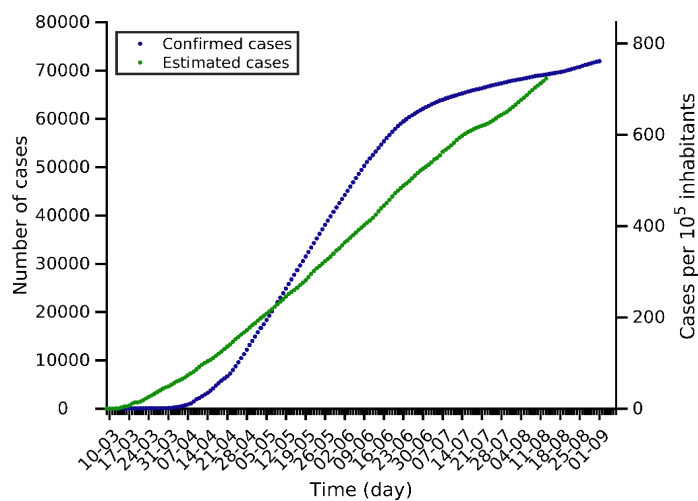
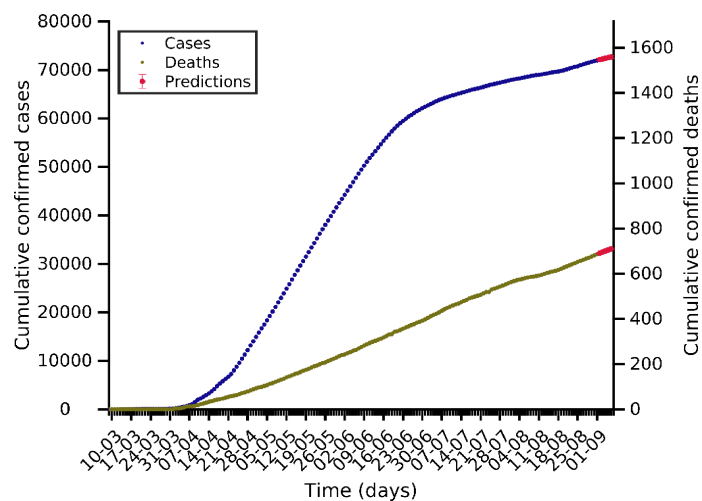
Qatar 01-09-2020. Pop: 2.9M. Cumulative incidence: 4130/10⁵



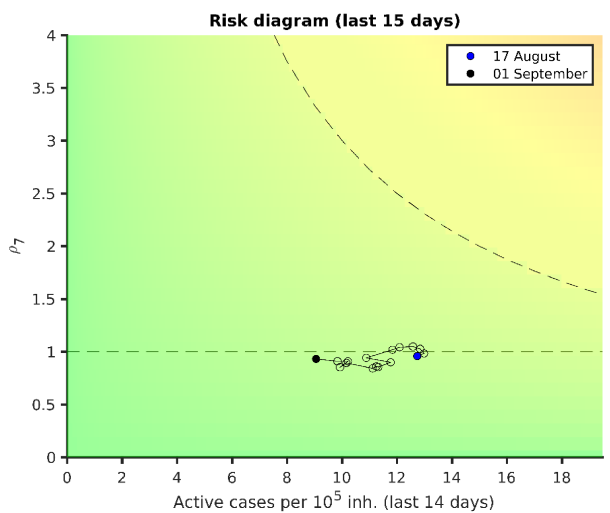
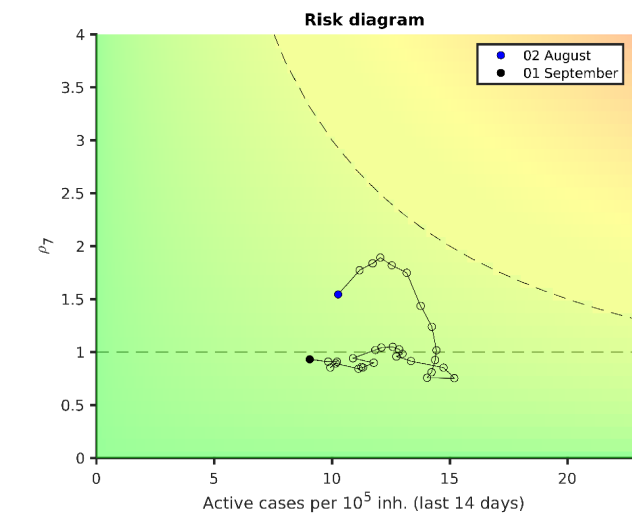
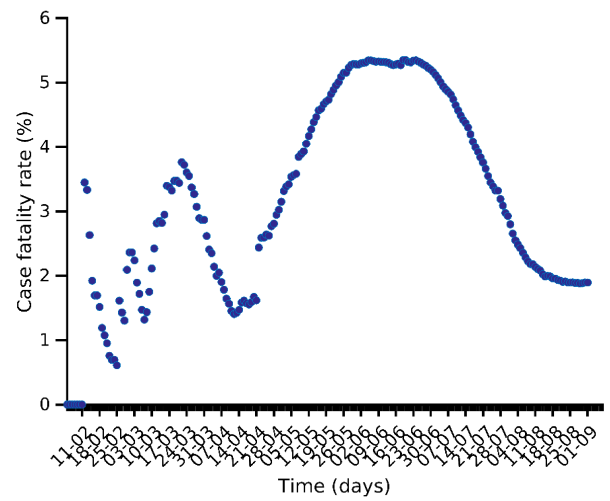
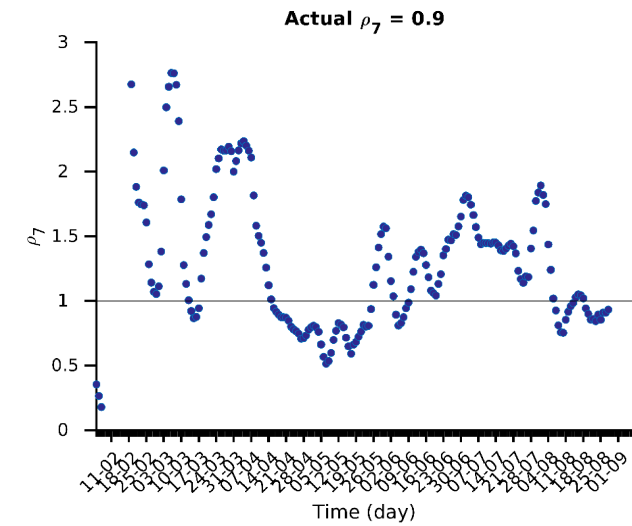
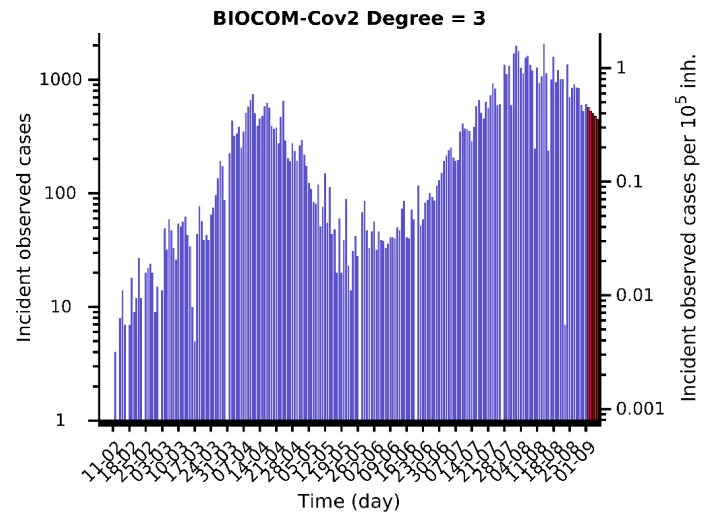
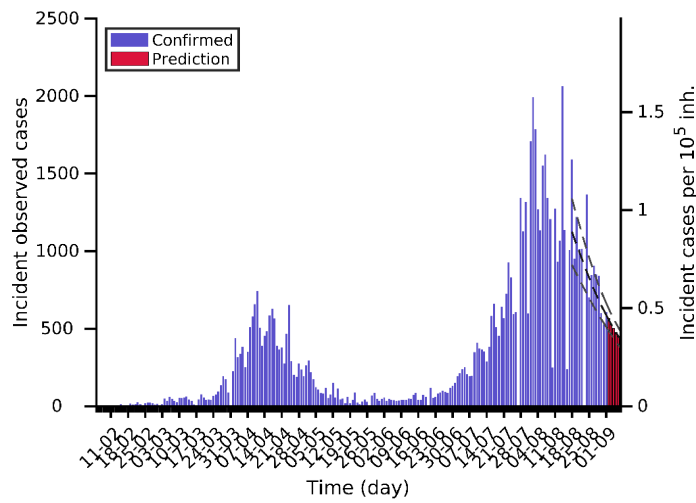
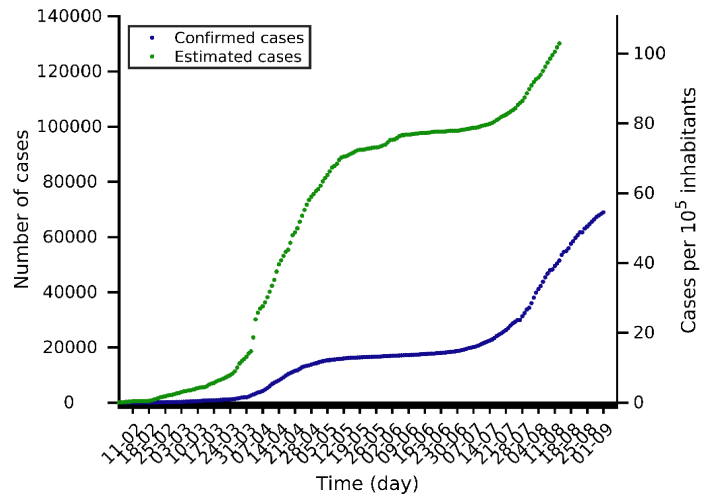
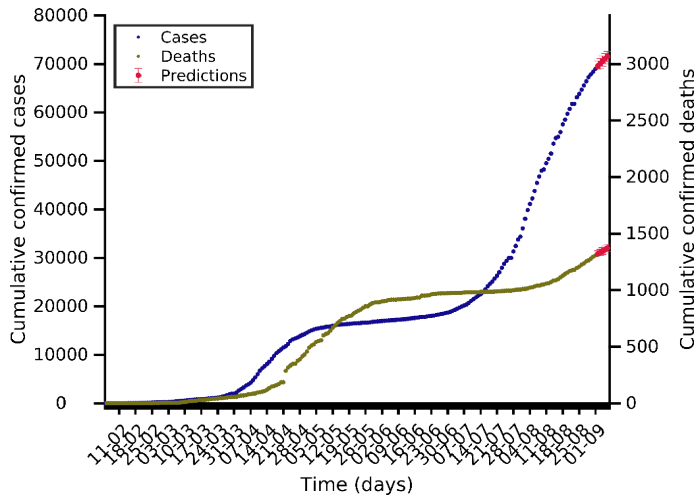
Ecuador 01-09-2020. Pop: 17.6M. Cumulative incidence: 648/10⁵



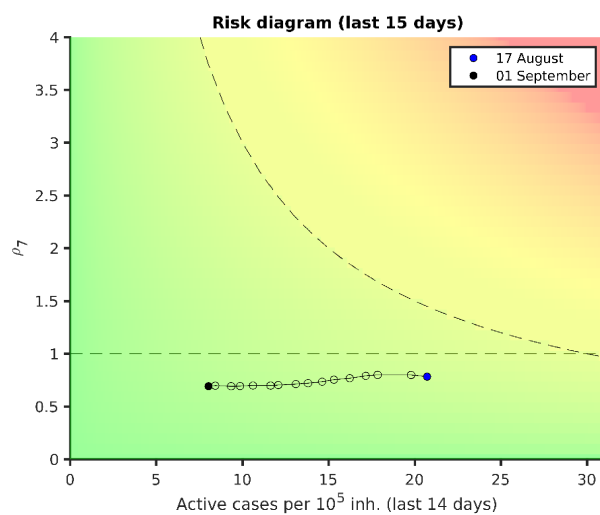
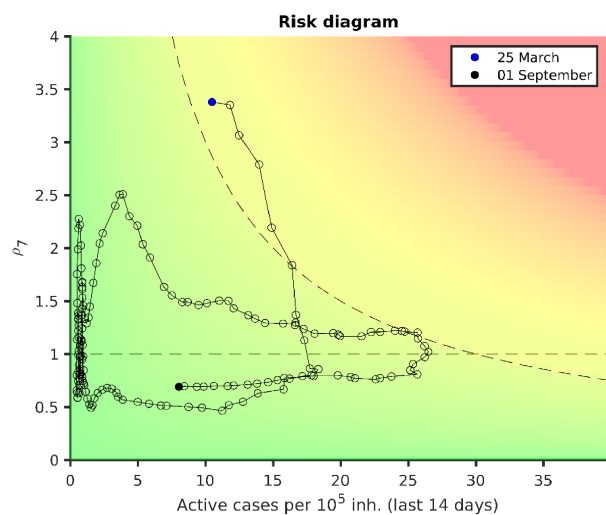
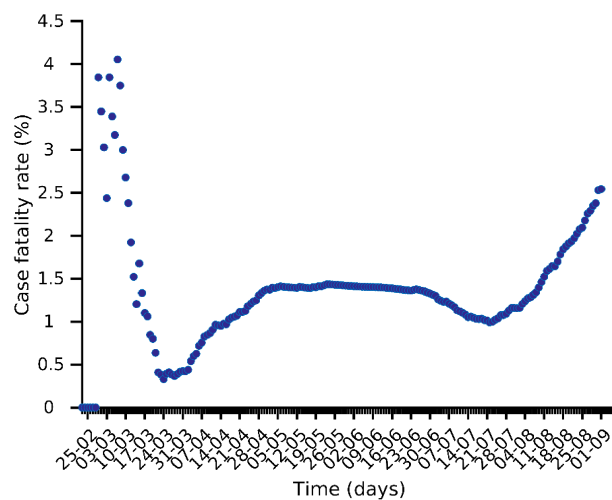
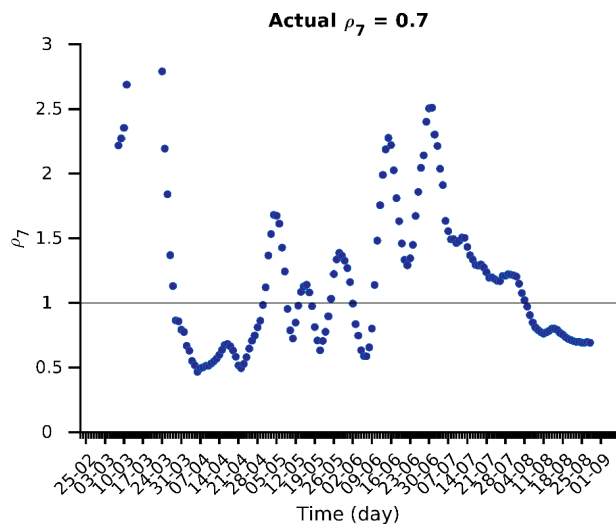
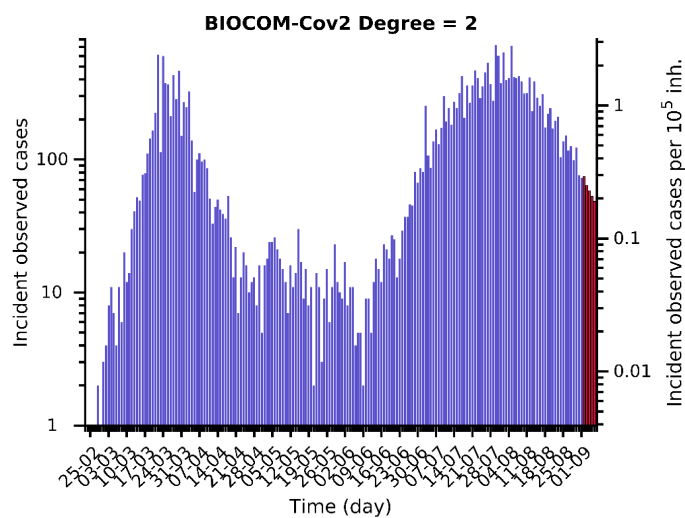
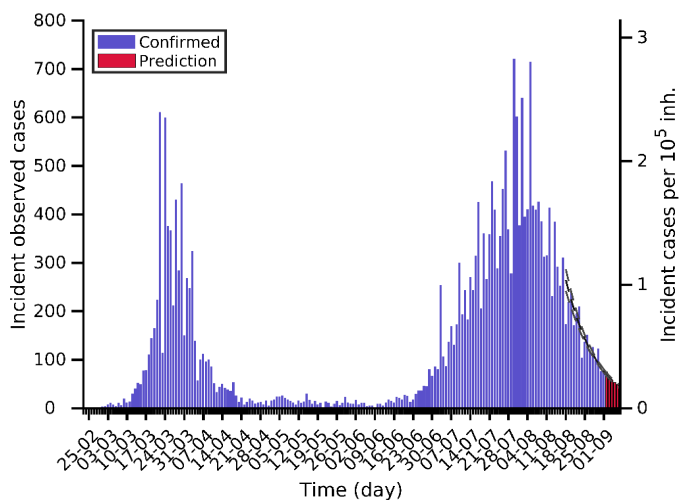
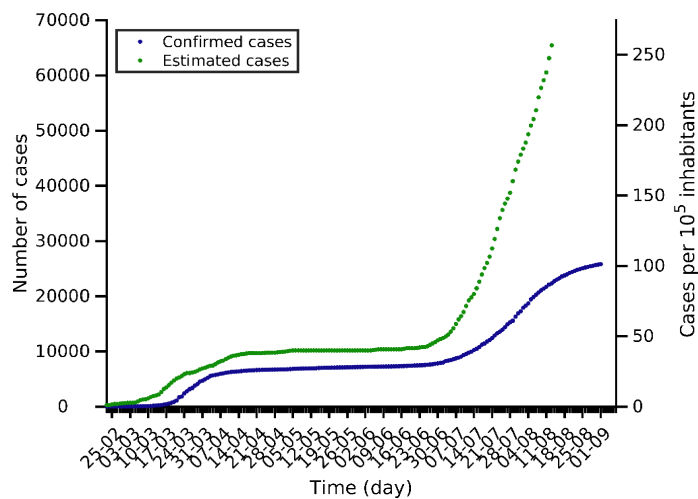
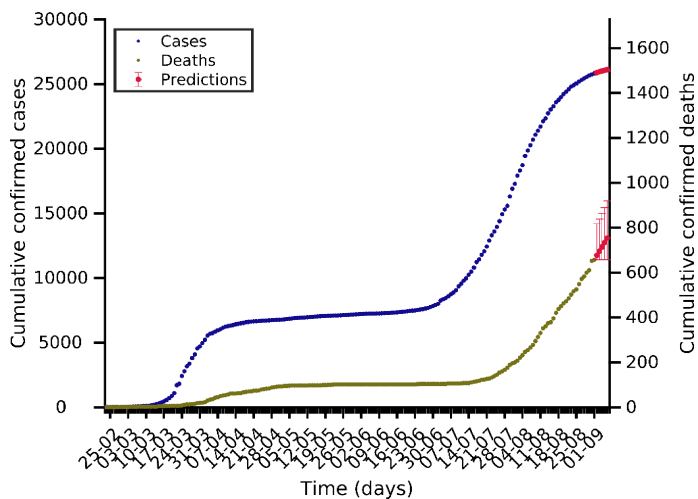
Belarus 01-09-2020. Pop: 9.4M. Cumulative incidence: 762/10⁵



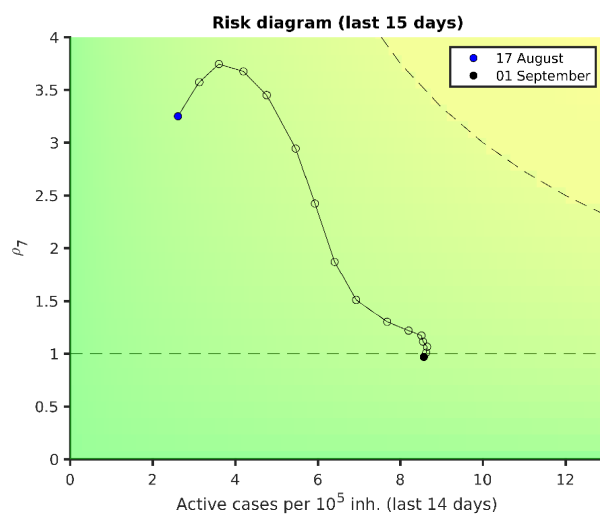
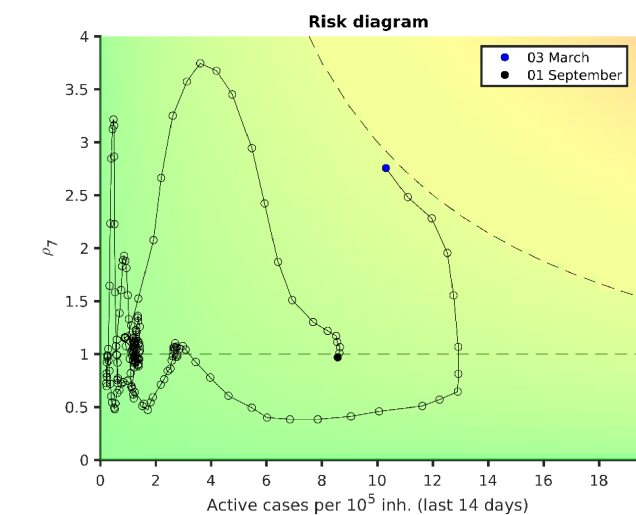
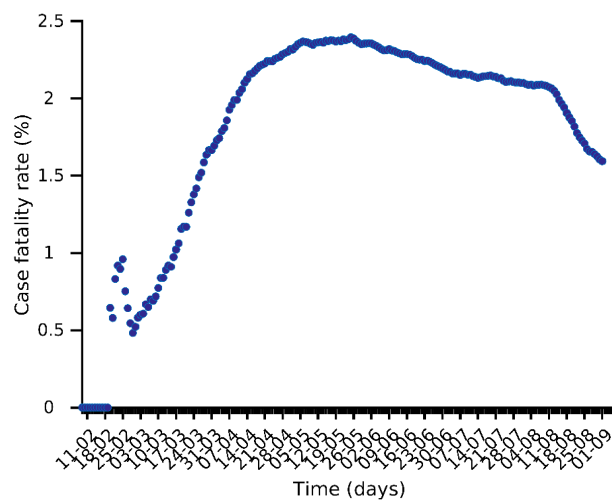
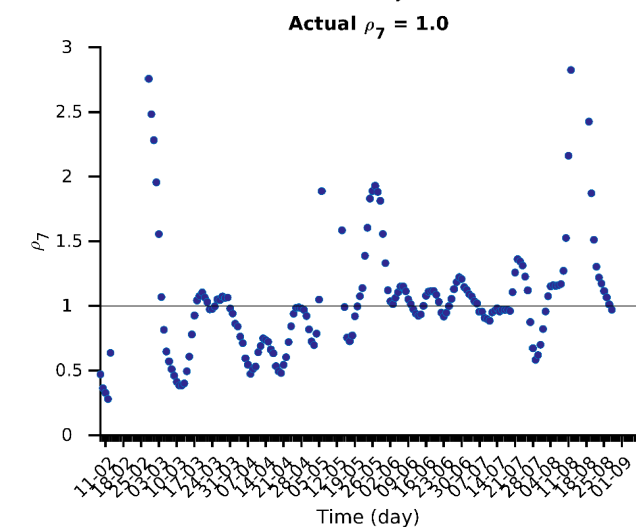
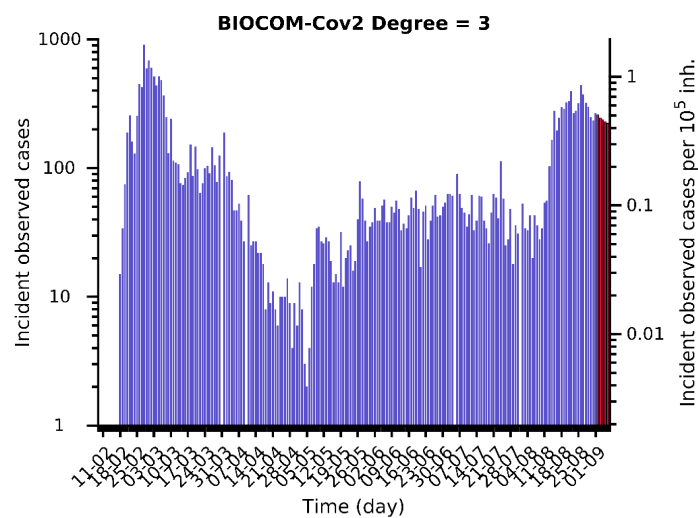
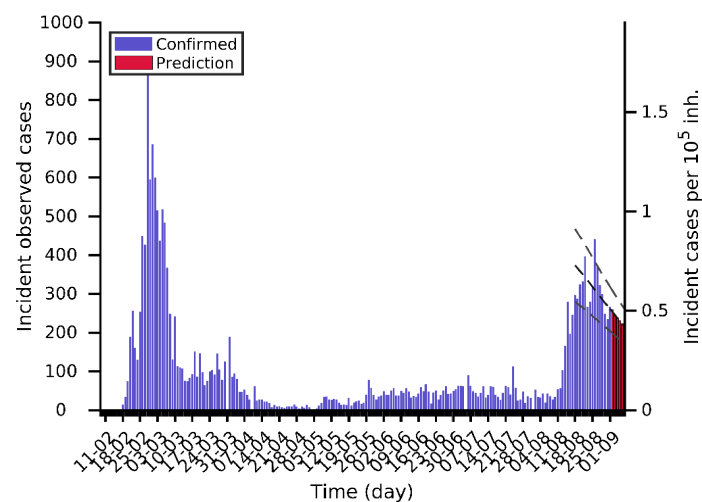
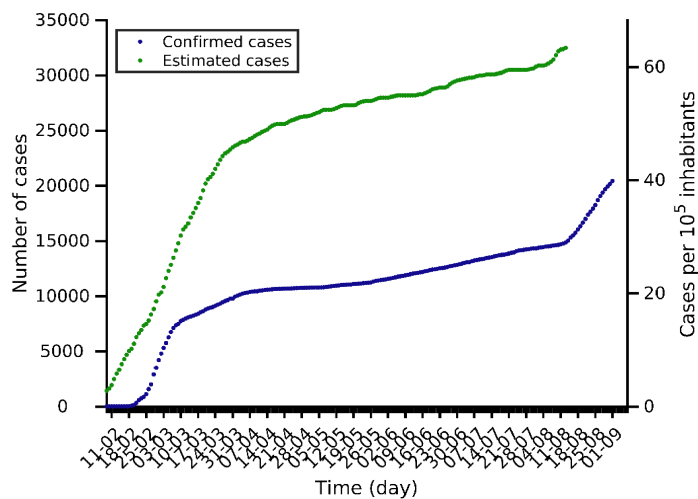
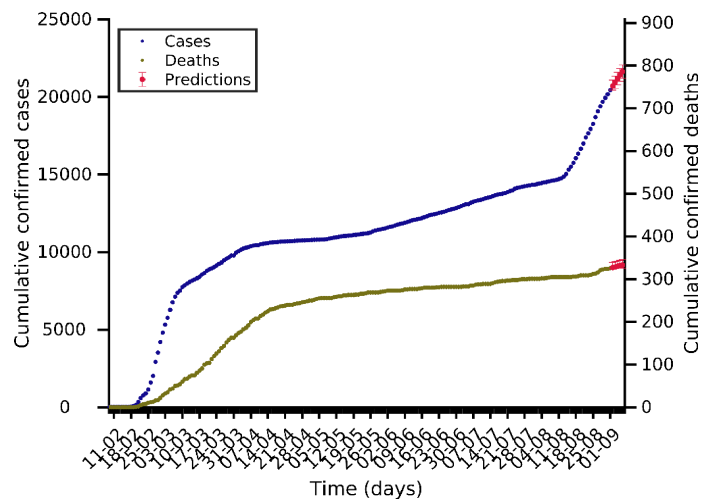
Japan 01-09-2020. Pop: 126.5M. Cumulative incidence: 55/10⁵



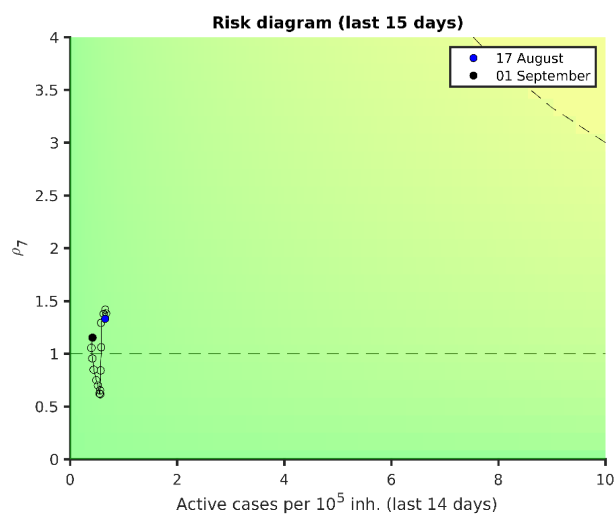
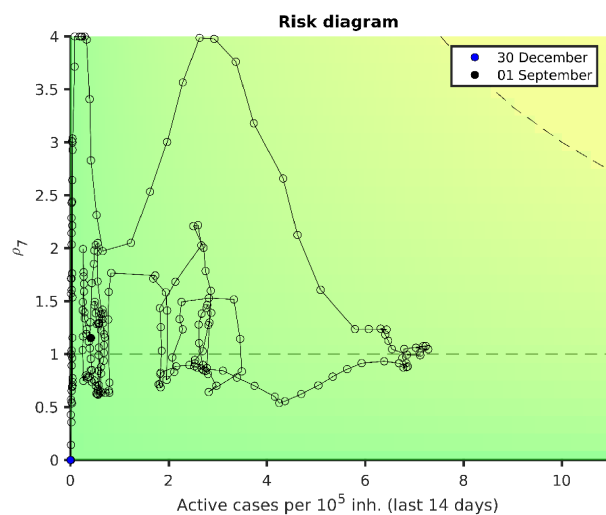
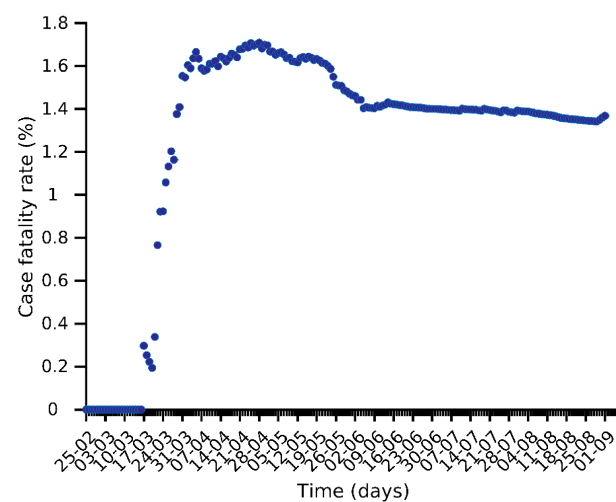
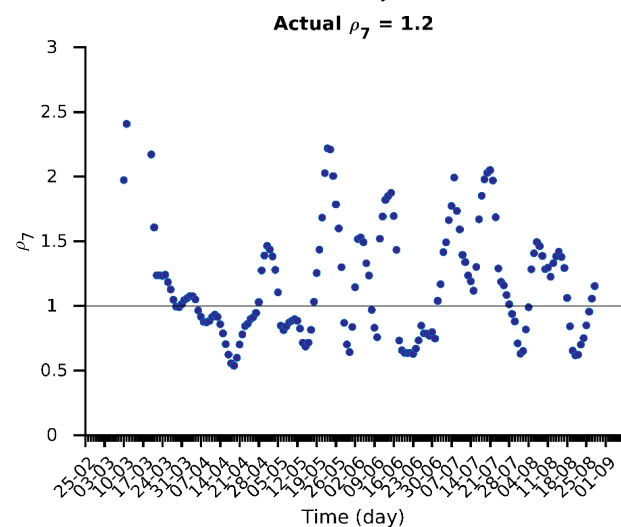
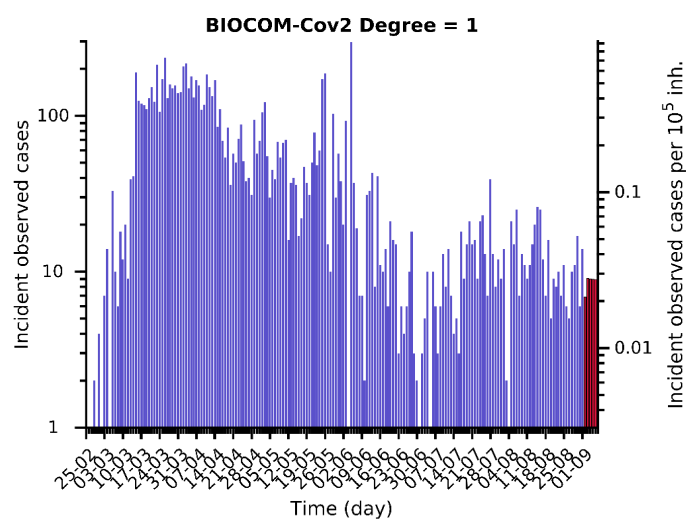
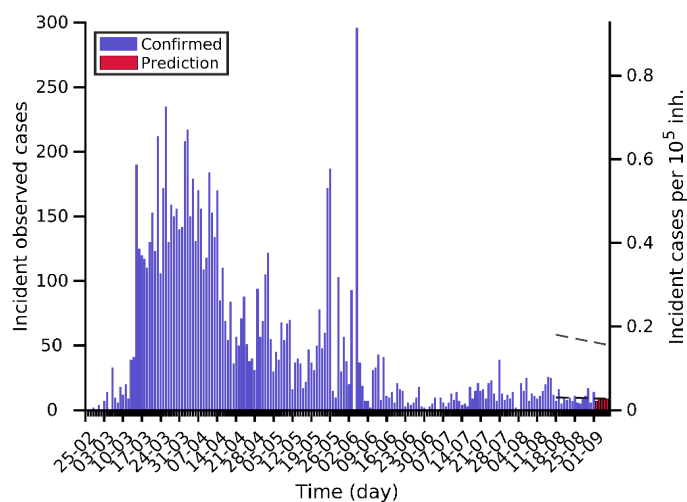
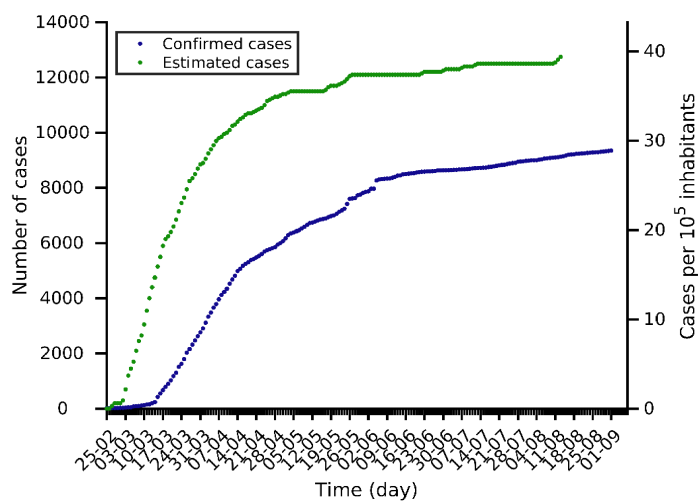
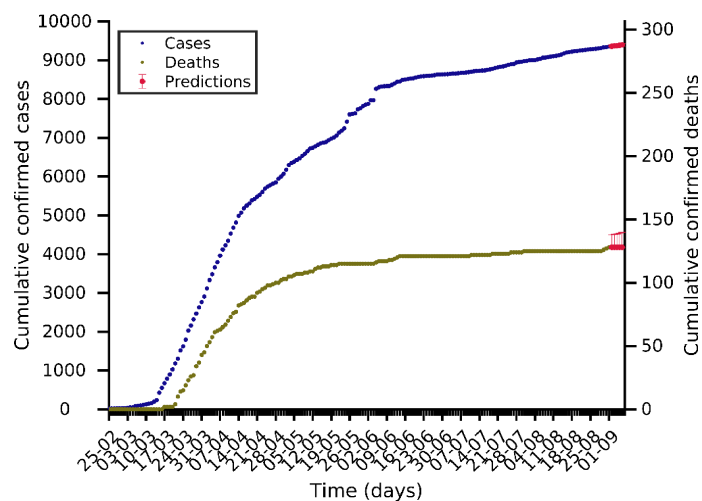
Australia 01-09-2020. Pop: 25.5M. Cumulative incidence: 101/10⁵



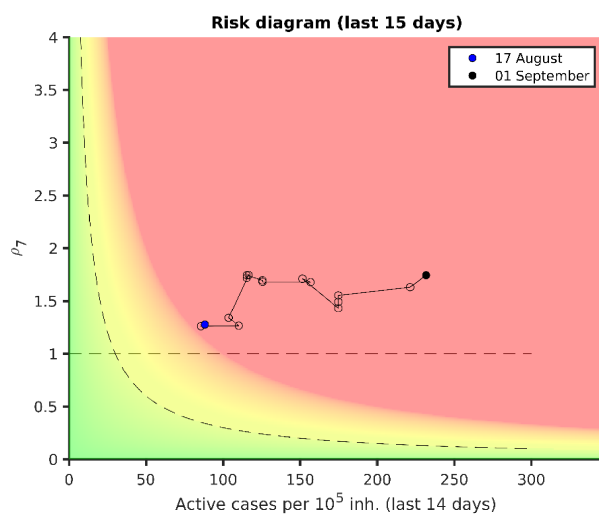
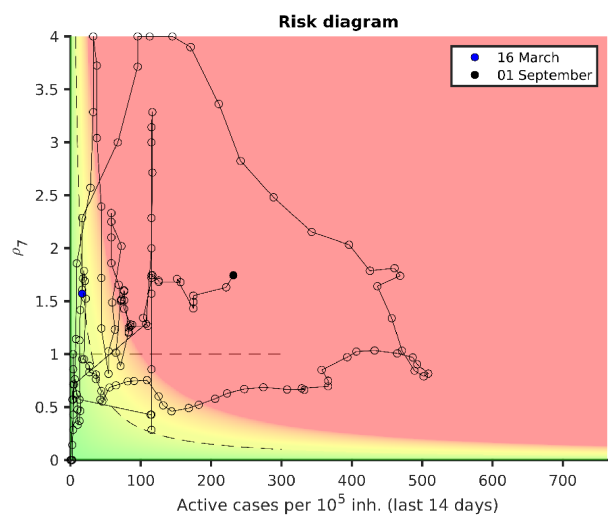
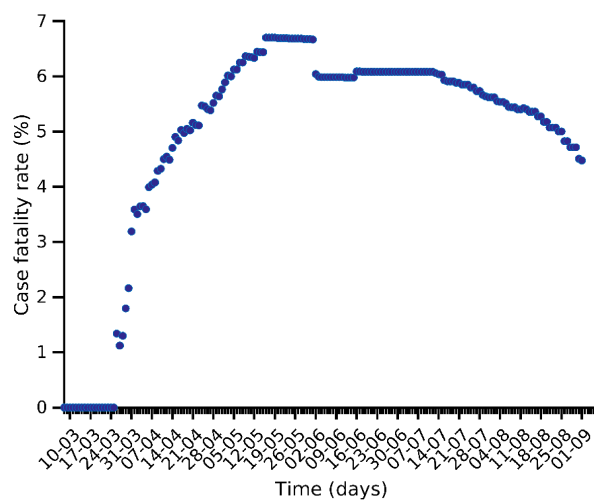
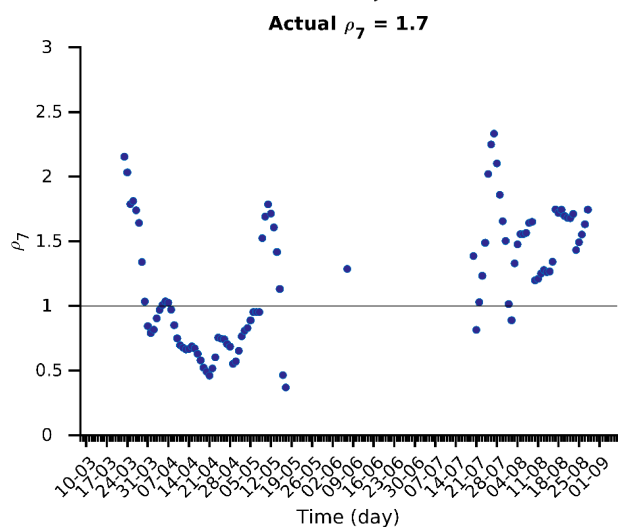
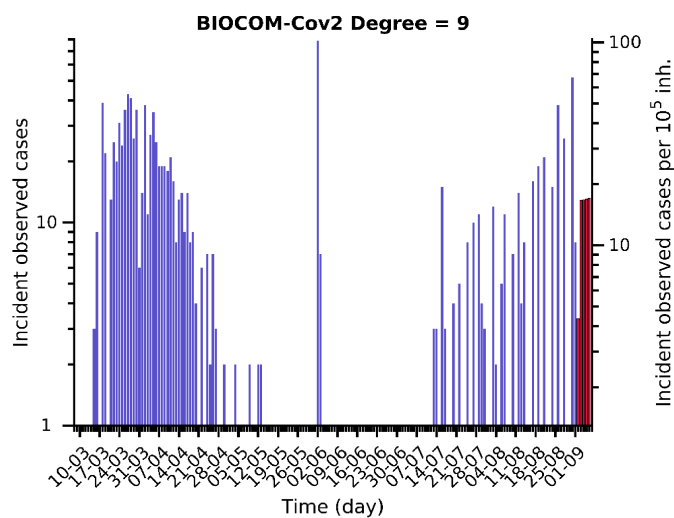
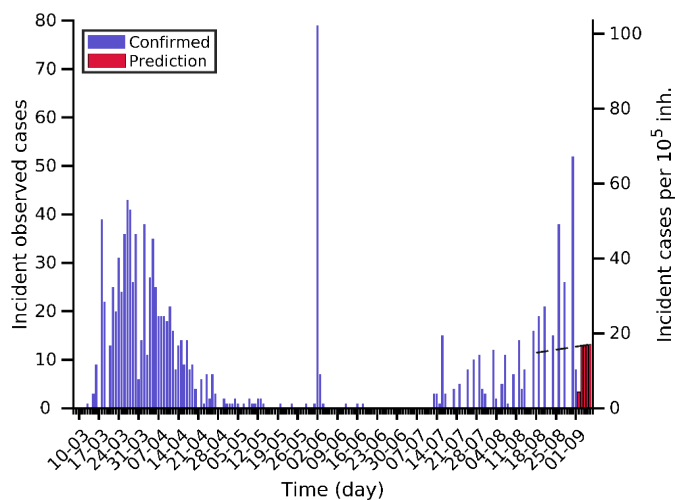
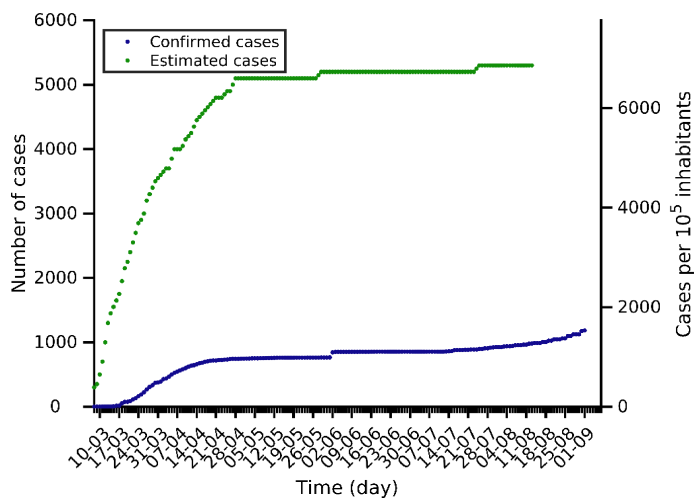
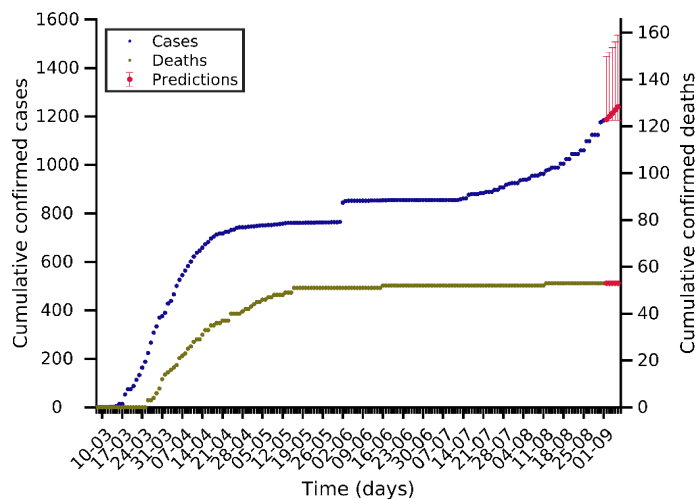
South Korea 01-09-2020. Pop: 51.3M. Cumulative incidence: 40/10⁵



Malaysia 01-09-2020. Pop: 32.4M. Cumulative incidence: 29/10⁵



Andorra 01-09-2020. Pop: 0.1M. Cumulative incidence: 1532/10⁵



Methods

Methods

(1) Data source

Data are daily obtained from European Centre for Disease Prevention and Control (ECDC)¹ and country official sources (when indicated). Daily data comprise, among others: total confirmed cases, total confirmed new cases, total deaths, total new deaths. It must be considered that the report is always providing data from previous day. In the document we use the date at which the datapoint is assumed to belong, i.e., report from 15/03/2020 is giving data from 14/03/2020, the latter being used in the subsequent analysis.

(2) Data processing and plotting

Data are initially processed with Matlab in order to update timeseries, i.e., last datapoints are added to historical sequences. These timeseries are plotted for individual countries and for the UE+EFTA+UK as a whole:

- ✓ Number of cumulative confirmed cases
- ✓ Number of reported new cases
- ✓ Number of cumulative deaths

Then, two indicators are calculated and plotted, too:

- ✓ Case fatality rate: number of cumulative deaths divided by the number of cumulative confirmed cases, and reported as a percentage; it is an indirect indicator of the diagnostic level.
- ✓ ρ : this variable is related with the reproduction number, i.e., with the number of new infections caused by a single case. It is evaluated as follows for the day before last report ($t-1$):

$$\rho(t-1) = \frac{N_{new}(t) + N_{new}(t-1) + N_{new}(t-2)}{N_{new}(t-5) + N_{new}(t-6) + N_{new}(t-7)}$$

where $N_{new}(t)$ is the number of new confirmed cases at day t . Then, we calculate a 7-day moving average (ρ_7) so that noise is reduced and trends become clearer.

(3) Classification of countries according to their epidemic level: the scale Biocom-Cov

Countries are assigned a degree in the discrete Biocom-Cov scale, which aims to facilitate a simple way of assessing the situation of the country. It is based on the level of daily new cases per 100,000 inhabitants as follows:

Pandemic degree	Daily new incident cases per 10 ⁵ inh.
0	0
1	0-0.1
2	0.1-0.5
3	0.5-1.25
4	1.25-2
5	2-3
6	3-5
7	5-8
8	8-14
9	>14

¹ <https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>

(4) Fitting a mathematical model to data

Previous studies have shown that Gompertz model² correctly describes the Covid-19 epidemic in all analysed countries. It is an empirical model that starts with an exponential growth but that gradually decreases its specific growth rate. Therefore, it is adequate for describing an epidemic wave that is characterized by an initial exponential growth but a progressive decrease in spreading velocity provided that appropriate control measures are applied. Once in the tail, predictions work but the meaning of parameters is lost.

Gompertz model is described by the equation:

$$N(t) = K e^{-\ln\left(\frac{K}{N_0}\right) \cdot e^{-\alpha \cdot (t-t_0)}}$$

where $N(t)$ is the cumulated number of confirmed cases at t (in days), and N_0 is the number of cumulated cases the day at day t_0 . The model has two parameters:

- ✓ α is the velocity at which specific spreading rate is slowing down;
- ✓ K is the expected final number of cumulated cases at the end of the epidemic.

This model is fitted to reported cumulative cases of the UE and of countries that accomplish two criteria: 4 or more consecutive days with more than 100 cumulated cases, and at least one datapoint over 200 cases. Day t_0 is chosen as that one at which $N(t)$ overpasses 100 cases. If more than 15 datapoints that accomplish the stated criteria are available, only the last 15 points are used. The fitting is done using Matlab's Curve Fitting package with Nonlinear Least Squares method, which also provides confidence intervals of fitted parameters (α and K) and the R^2 of the fitting. At the initial stages the dynamics is exponential and K cannot be correctly evaluated. In fact, at this stage the most relevant parameter is α .

It is worth to mention that the simplicity of this model and the lack of previous assumptions about the Covid-19 behaviour make it appropriate for universal use, i.e., it can be fitted to any country independently of its socioeconomic context and control strategy. Then, the model is capable of quantifying the observed dynamics in an objective and standard manner and predicting short-term tendencies.

(5) Using the model for predicting short-term tendencies

The model is finally used for a short-term prediction of the evolution of the cumulated number of cases (3-5 days). The confidence interval of predictions is assessed with the Matlab function `predint`, with a 99% confidence level. These predictions are shown in the plots as red dots with corresponding error bar. For series longer than 9 timepoints, last 3 points are weighted in the fitting so that changes in tendencies are well captured by the model.

(6) Estimating non-diagnosed cases

Lethality of Covid-19 has been estimated at around 1 % for Republic of Korea and the Diamond Princess cruise. Besides, median duration of viral shedding after Covid-19 onset has been estimated at 18.5 days for non-survivors³ in a retrospective study in Wuhan. These data allow for an estimation of total number of cases, considering that the number of deaths at certain moment should be about 1 % of total cases 18.5 days before. This is valid for estimating cases of countries at stage II, since in stage I the deaths would be mostly

² Madden LV. Quantification of disease progression. *Protection Ecology* 1980; **2**: 159-176.

³ Zhou et al., 2020. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *The Lancet*; March 9, doi: 10.1016/S0140-6736(20)30566-3

due to the incidence at the country from which they were imported. We establish a threshold of 50 reported cases before starting this estimation.

Reported deaths are passed through a moving average filter of 5 points in order to smooth tendencies. Then, the corresponding number of cases is found assuming the 1 % lethality. Finally, these cases are distributed between 18 and 19 days before each one.